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The Value of Imagination

WE THINK of dreams, of visions, imaginings, as connoting indolence, lack of practicality, inability to get things done.

And yet every great work, not only of art and literature but of architecture, engineering and industry, existed first as a vision in the mind of its originator.

After the birth of the idea that such a thing might be done, comes the visualization of the form that it might take, and here the "idle dreamer" gets through.

But the artist recreates his dream on canvas or in clay, the architect computes the carrying powers of foundations, walls and columns and proves the physical possibility of his conception, the engineer figures loads and stresses and cunning mechanisms and turns out secure and useful structures and powerful and ingenious machines.

The industrialist conceives a great system and with the help of the engineer lays out and co-ordinates its various members so that they work together for the effecting of a useful purpose.

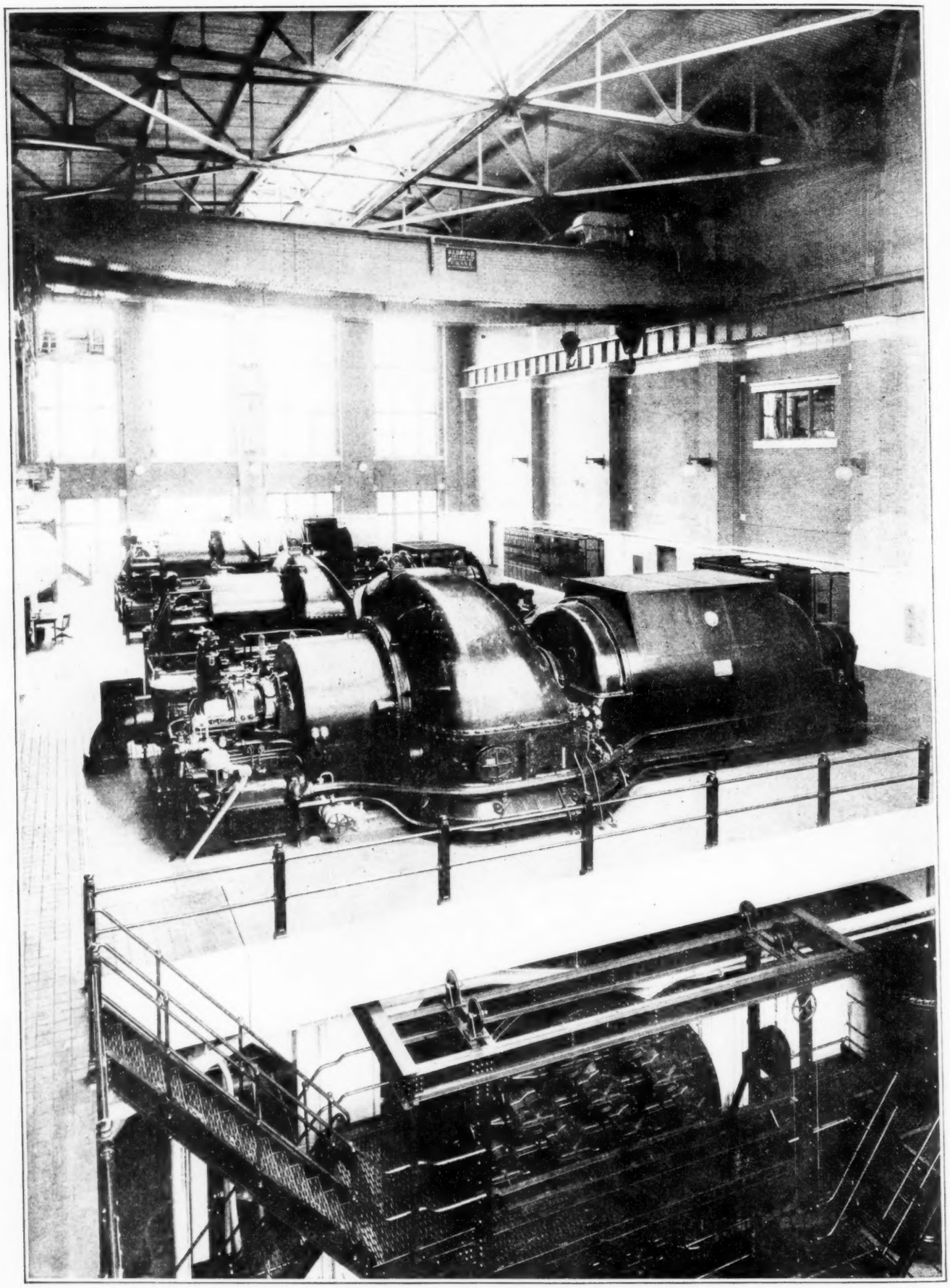
Seldom, especially in the mechanical and industrial lines, is the finished product identical with the initial conception. One step suggests a modification of the next, and ideas arising from development may lead to extensive revision.

And here is where the value of the vivid imagination, that faculty of visualizing a thing yet uncreated, comes in.

Where one man has to do a thing over two or three times on paper or in the material to whip it into shape, another will think it out, see it through in his mind and go directly to the finished product when he begins the material work.

I refer now, not to the great and occasional visions that fructify into notable achievements, but to the cultivation of the power of visualization, the exercise of the imagination in the everyday work of life and the details of the job.

F. R. Low



Turbine room of Saxton Station with new unit in foreground

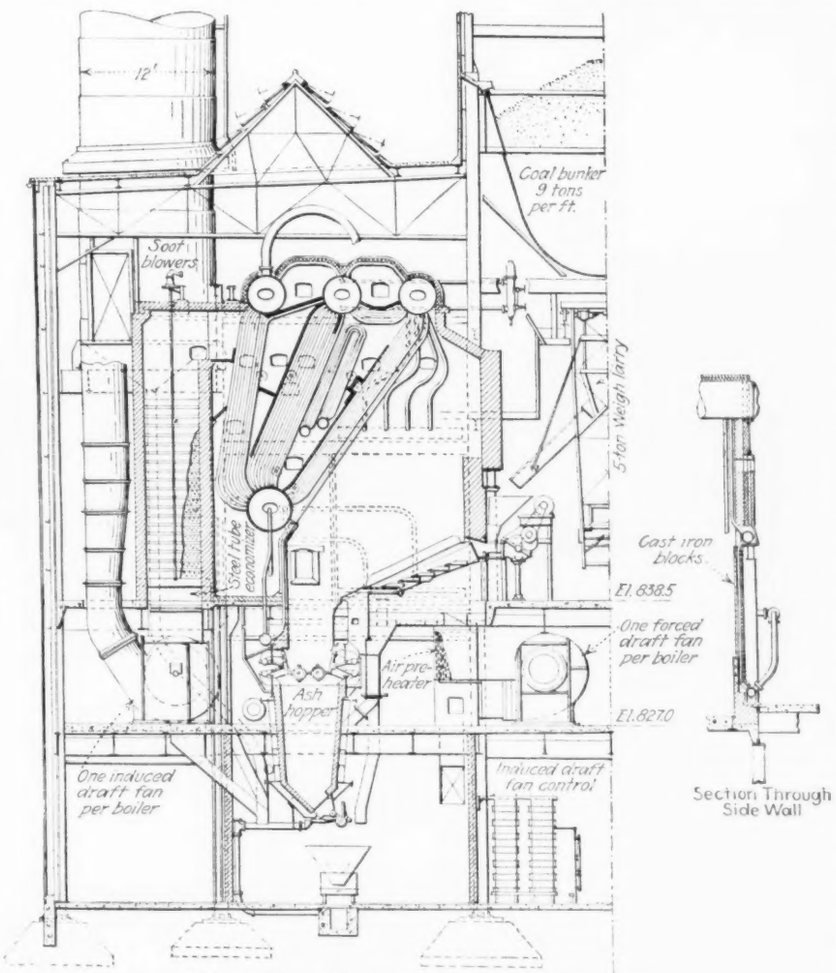
Addition to Saxton Plant of Penn Central Light & Power Company

By Alfred Iddles

Chief Engineer, Day & Zimmermann Engineering & Construction Co.

POWER for April 15, 1924, described the first section of the new steam station of the Penn Central Light & Power Company at Saxton, Pa.

In touching some of the high lights of the first installation, it should be stated that it was a good illustration of a mine-mouth plant, mentioned so often in articles on superpower systems. Coal of a good quality is mined within a few miles, and there is sufficient cooling water for a station of approximately 100,000 kw. The first installation was 20,000 kw. in two units; the second is 30,000 kw. in one unit, which this article will describe. Steam is supplied to the turbine throttles at 260 lb. pressure and 650 deg. temperature. All high-pressure pipe joints are of the Sargol welded type. Double-length pipe has been used wherever possible, to eliminate flanged joints. All motors for circulating pumps, induced- and forced-draft fans are 2,200 volts with push-button automatic control. Smaller motors are 440 volts with hand control. The motors driving the coal-handling system are 440 volts with push-button automatic control. Auxiliaries of the first installation were motor driven with the exception of the boiler-feed pumps, the spare exciter, the spare condensate pumps and the spare house service pump. A 750-kw. house turbine-generator, as part of the first installation, supplies part of the power to drive the station auxiliaries and permits control of the heat balance.



This setting will develop up to 450 per cent of boiler rating

For the first 20,000-kw. installation there were four 11,120-sq.ft. boilers, each with a 6,737-sq.ft. economizer, and an 11-retort, 25-tuyere clinker-grinder stoker. On account of the low cost of coal it was quite desirable to keep the investment costs per unit of capacity to a low figure.

Four more boilers of the same size were planned to carry the 30,000-kw. unit, calling for a steam output of nearly 50 per cent more than the first installation. But to realize this additional output several interesting changes were made in the original design. First, a 33-tuyere stoker was used instead of a 25-tuyere, giving a 20 per cent increase in grate area. Room for this longer stoker was provided by the elimination of the heavy firebrick bridge wall of the first design. A water screen for the rear furnace wall permitted this. The overfeed section of the stoker was also made more effective through the replacement of stationary grates by a moving overfeed section, and the clinker pit made deeper for more thorough burning of the fuel. In order to increase safely the coal-burning rate per square foot of grate area by 30 per cent, water screens were installed on both side walls and the bridge wall. On the bridge wall this was accomplished by extending the front row of tubes to a forged steel header about twelve feet below the mud drum. This header is connected to the mud drum by

means of twenty circulating tubes, which permit the water to circulate from the mud drum through the header and up the first row of tubes to the front steam drum. This front row of tubes between the forged-steel header and the mud drum is covered by cast-steel blocks which, in addition to absorbing the heat and transmitting it to the water within the tubes, also form the bridge wall in that they prevent the furnace gases from passing below the mud drum. Each water-cooled side wall consists of twenty-two bent tubes, also covered by cast-steel blocks. These bent tubes are connected top and bottom to forged steel headers. The bottom header is connected to the side of the mud drum with two circulating pipes placed outside of the furnace. The top header is connected to the front steam drum by means of four circulating tubes located inside the furnace. These screen tubes with their clamped-on blocks and backed up by a coating of plastic insulating material, form the furnace wall, no brick or casing being used.

The results obtained with these furnaces have exceeded expectations largely because the beneficial actions of furnace cooling, effective heating surface and better combustion through better fuel-bed conditions, are cumulative, all tending to increase capacity and efficiency.

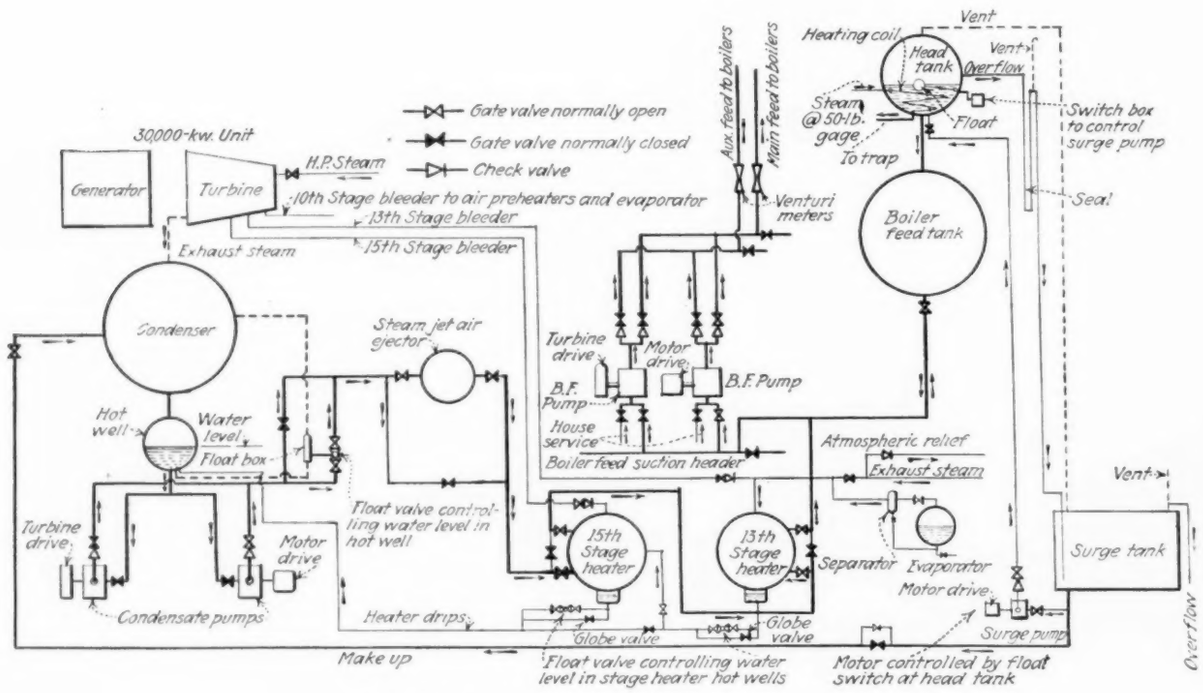
To counterbalance the cooling effect of the furnace wall screens on furnace gases, a 33 per cent larger superheater was necessary.

Since experience has shown that preheated air will reduce combustion troubles, especially when the fires are forced, it was thought that air preheaters might be used to advantage in this plant. Careful studies of the gains obtainable by reducing the flue-gas temperature indicated that air preheaters installed in the flue-gas passage would not be economical on account of cost compared to the probable saving. Further studies revealed that an air preheater operated on bleeder steam at 50 lb. gage pressure could be installed at low cost and would show an economic advantage. This preheater made of bent pipe is installed in the forced-draft air duct between the fan and stoker. The air will be heated to approximately 200 deg. F. and though this is not as high as might be obtained by the flue-gas preheater, it is found that it aids combustion and by reducing condenser losses will pay for itself in a short time.

It has been found that these furnaces will develop 350 per cent boiler rating economically and 450 per cent is available in times of emergency.

One induced-draft fan per boiler is used, driven by a slip-ring motor with push-button and speed control at the boiler-room gage board. There is one forced-draft fan per boiler.

The stokers are driven by a variable-speed motor with control at the boiler-room gage board. Two motors are installed per stoker, one being a 7½-hp., the other a 15-hp.

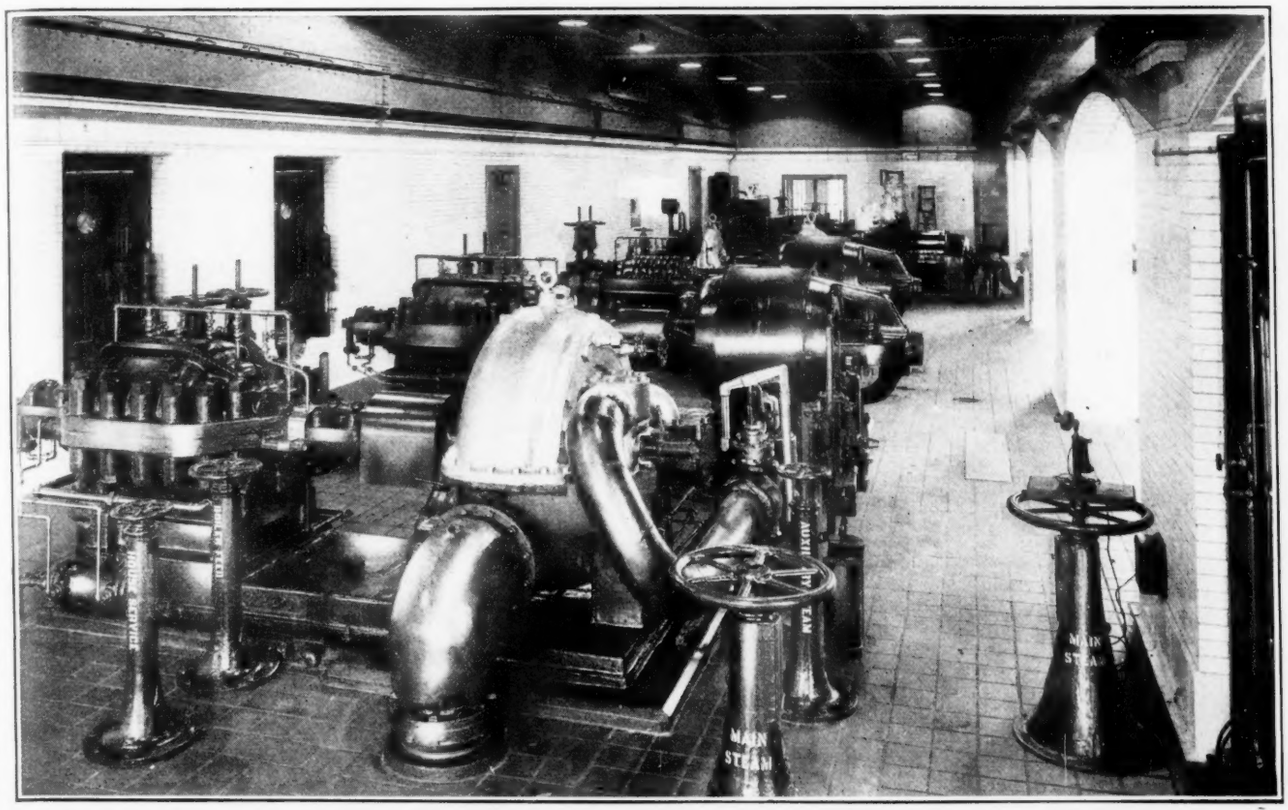


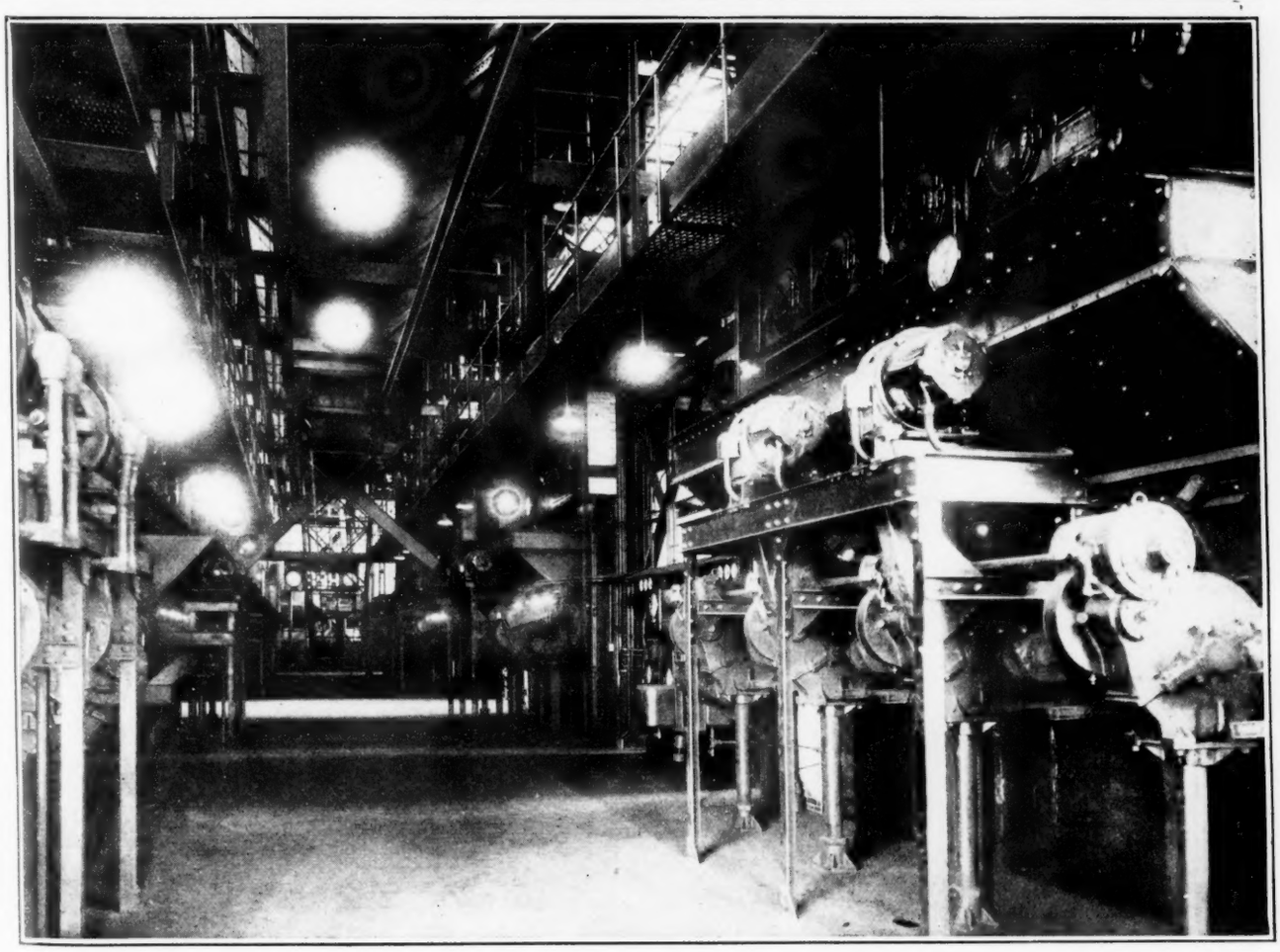
Heat balance diagram of second section unit

Steam pressure and draft are automatically controlled.

The seventeen-stage 30,000-kw. turbine is bled at three points—the tenth, thirteenth and fifteenth stages. The tenth stage steam is used for heating combustion air and evaporating makeup feed water, the thirteenth and fifteenth stages for feed-water heating in two closed heaters. The thirteenth stage heater also serves as an evaporator condenser and has a connection to the auxiliary exhaust steam line. Condensation from the two closed feed-water heaters, which includes makeup, is returned to the condenser hotwell.

The condenser is two-pass, single-compartment type containing 40,000 sq.ft. of cooling surface of Muntz metal tubes. It is mounted on springs. Two motor-driven circulating pumps delivering a maximum of 44,000 g.p.m. handle the cooling water. Each pump takes water from an independent intake canal. Except when the circulating water is warm, one pump only is normally in operation supplying 30,000 g.p.m. There are two condensate pumps, one motor- and one turbine-driven. The steam-jet air pumps are in triplicate, only two of which are used simultaneously.





Upper view shows turbine and motor driven pumps in auxiliary bay; lower view, looking down boiler aisle

The house turbine, which was in the first installation, is of a sufficient size to supply the energy for the auxiliary motors that are essential to the operation of the plant. Normally, these motors (one circulating-pump motor per turbine, one induced-draft fan per boiler, etc.) are connected to the house turbine bus and all motors not essential to the continuous operation of the plant are connected to the station auxiliary bus. In the event of trouble which interferes with the supply of power from the main station bus, the house turbine and the auxiliary motors connected to it are isolated automatically, the house turbine supplying the essential auxiliaries.

Exhaust steam from the house turbine is automatically regulated in amount so that, together with exhaust from any steam auxiliaries that are running, there is just sufficient to raise the condensate from the two 10,000-kw. machines to 205 deg. The feed-water heating by exhaust steam in the first installation is accomplished in a jet type of heater condenser. The condensate from the 30,000-kw. unit first passes through the intercooler and after condenser of the air pumps, then through the two stage heaters to the feed-pump suction.

Connected into the boiler-feed pump suction header is an elevated storage tank to take ordinary fluctuations in rate of boiler feed. If the level should fall below a predetermined point in this tank, a pump automatically starts and delivers water from two large surge tanks on a lower level. Any overflow from the tank in the boiler-feed suction goes to these same surge tanks.

The main units may be connected to one of a duplicate set of 13,200-volt buses, either of which supplies outgoing feeders for local coal-mining load. Power for long-distance transmission is fed from this duplicate bus system through two banks of single-phase water-cooled transformers which raise the potential to 45,000 volts. The ultimate transmission voltage will be 110,000.

The station was designed and constructed by Day & Zimmerman, Inc., Philadelphia, Pa., in co-operation with the engineers of the Penn Central Light & Power Co., Altoona, Pa.

PRINCIPAL EQUIPMENT IN ADDITION TO SAXTON STATION OF PENN CENTRAL LIGHT & POWER CO.

GENERAL

Capacity, ultimate	110,000 kw. (5 units)
Capacity, present	50,000 (3 units)
Area of ultimate station, sq.ft. per kilowatt	0.58

BOILERS

Number	8 Stirling (Babcock & Wilcox Co.)
Boiler pressure gage, lb.	300 lb.
Water-heating surface, sq.ft., each	11,120
Water-cooled furnace walls	Bailey, bare steel block
Water-cooled side-wall sur., sq.ft.	210
Water-cooled bridge-wall sur., sq.ft.	200
Ratio water heating surface to grate area	48 to 1
Water heating surface per kw., sq.ft.	1.55
Furnace volume, cu.ft.	4,900
Ratio furnace volume to water heating surface	1 to 4.2
Ratio furnace volume to projected grate area	20 to 1
Economizers	Duratex (B. & W.)
Location	Rear of boilers
Heating surface, each, sq.ft.	6,737
Superheating surface per boiler, sq.ft.	1,999
Steam temperature at 300 per cent rating, deg.	665
Corresponding superheat, deg.	250
Steam outlet from superheaters	One 8-in.

AIR PREHEATERS

Manufacturer	York Heating & Ventilating Co.
Surface, sq.ft.	3,600
Capacity	44,000 cu.ft. air per min. from 70 to 200 deg. F. with 50 lb. steam pressure

STOKERS

Type (2nd) installation	Taylor (American Eng. Co.)
Stoker motors each stoker	2—var. sp. (1—15 hp., 1—7.5 hp.)
Clinker grinders, type	2 roll, motor driven

COAL

Kind	Bituminous run of mine
Region	Broad Top Mountain, Pa.
Proximate Analysis:	
Fixed carbon, per cent	69
Volatile matter, per cent	19
Ash, per cent	10
Moisture, per cent	2
Total	100
Sulphur per cent	2.27
Heat value, B.t.u.	13,700
Ash fusing temp., deg. F.	2,500

CHIMNEYS

Number present	4 steel (Connery)
Height above boiler-room floor, ft.	96
Diameter at top floor, ft.	12
Chimney supported on	Structural steel

FORCED- AND INDUCED-DRAFT FANS

Manufacturer, second installation	American Blower Co.
Forced draft, 1 per boiler	Double-side-inlet, bottom horizontal discharge
Capacity, cu.ft. per min. at 6-in. water pressure	65,800
Forced-draft fan drive	One motor, 50 hp., 900 r.p.m. One motor, 100 hp., 1,200 r.p.m.
Induced-draft fans, 1 per boiler	Sirocco type, single side-inlet
Capacity, cu.ft. per min. at 7 in. of water static pressure	90,000
Drive	300 hp. variable speed, 2,200 volt

MAIN TURBINE-GENERATOR — SECOND INSTALLATION

Manufacturer	General Electric Co.
Generator	3-phase, 60 cycle, 13,200 volts
Ventilation	95,000 cu.ft. air per min. closed cir.
Turbine guaranteed	At 1½ in. back pressure
Kw. load	Lb. steam per kw.-hr.
15,000	11.5
20,000	10.95
23,000	10.7
30,000	10.85

CONDENSER AND PUMPS

Manufacturer	Wheeler Cond. & Eng. Co.
Tube surface, sq.ft.	40,000
Support	Springs
Circulating pumps	2 will pump 44,000 g.p.m. 1—30,000 g.p.m.
Drive	250-hp., 360 r.p.m. motor
Condensate pumps	2— one motor, one turbine-driven
Radojet air pumps	3

STAGE HEATERS

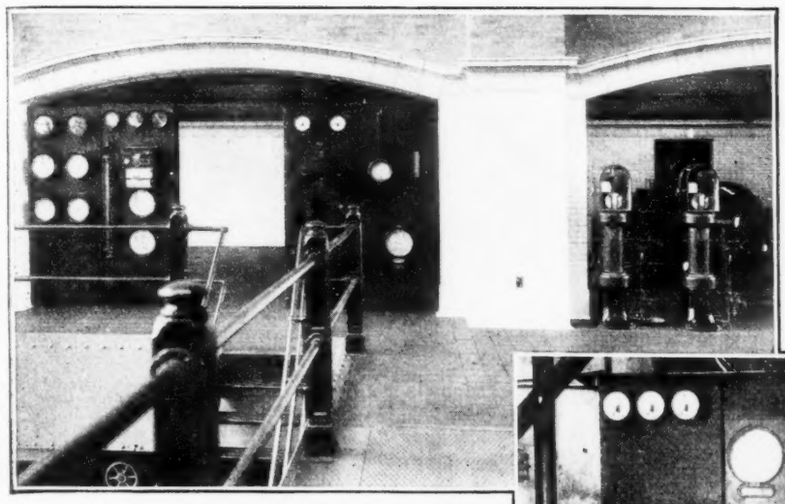
Manufacturer	Griscom-Russell Co.
Capacity, 15th stage	340,000 lb. per hr. from 90 to 148 deg. F.
Capacity, 13th stage	340,000 lb. per hr. from 148 to 212 deg. F.

BOILER-FEED PUMPS

Manufacturer	Ingersoll-Rand Co.
Type	One 5-stage, one 4-stage
Pressure, lb.	375
Capacity	Both 1,200 g.p.m.
Drive, 5-stage pump	400 hp. motor
4-stage pump	380 hp. turbine
Automatic control	Hagan
Manufacturer	DeLaval Steam Turbine Co.
Type	One-5-stage, 850 g.p.m.
Drive	Variable-speed motor
Automatic control	Hagan

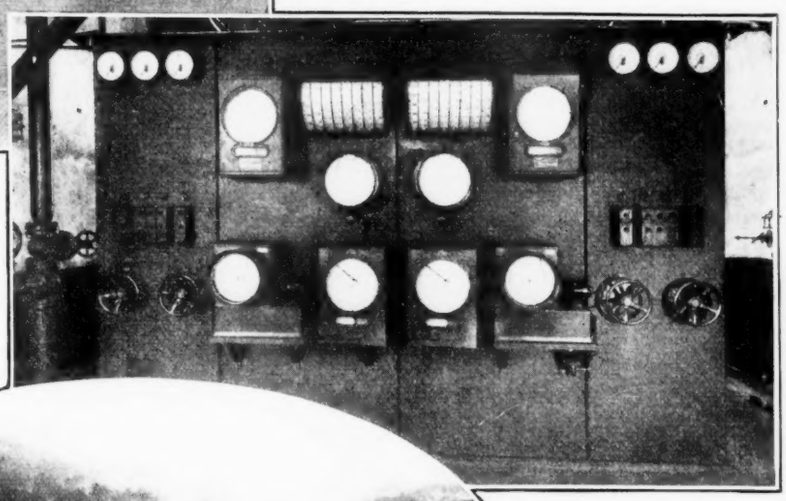
MISCELLANEOUS EQUIPMENT

House-service pump	DeLaval Steam Turbine Co.
Surge pumps	DeLaval Steam Turbine Co.
Venturi meters	Simplex Valve & Meter Co.
Feed-water regulators	Northern Equipment Co.
Non-return valves	Edward Valve Co.
Combustion and damper control	Hagan Corp.
Soot blowers	Diamond Power Specialty Co.
Boiler meters	Bailey Meter Co.
Strainers	Elliott Co.
Safety valves	Ashton Valve Co.
Blow-off valves and cocks	Yarnall-Waring Co.
Smoke flues and forced-draft ducts	Connery Co.
Condenser tubes	Wheeler Condenser & Eng. Co.
Atmospheric relief valve	C. H. Wheeler Mfg. Co.
Operating and control mechanism for motor-operated valves	Payne Dean, Ltd.
Recording and indicating gages	Foxboro Co. Republic Flow Meters Co. Ashcroft Mfg. Co. Electro Tachometer Co. Brown Instrument Co. Bailey Meter Co. Leeds & Northrup Co. Crosby Steam Gage & Valve Co. Am. Schaeffer & Budenberg Corp. Sherman Eng. Co. Pneumercator Co.
Gratings for walkways	Irving Iron Works
Surge and storage tanks	New York Central Iron Works.
Piping	Pittsburgh Valve Foundry & Construction Co.

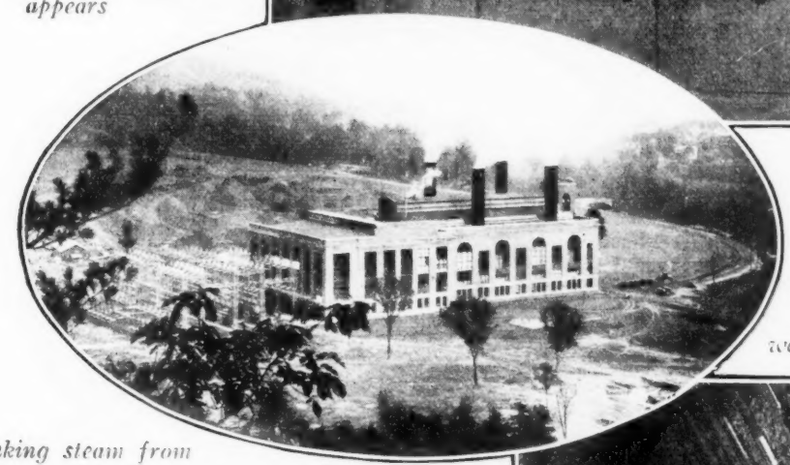


Left: Instrument board and venturi meters

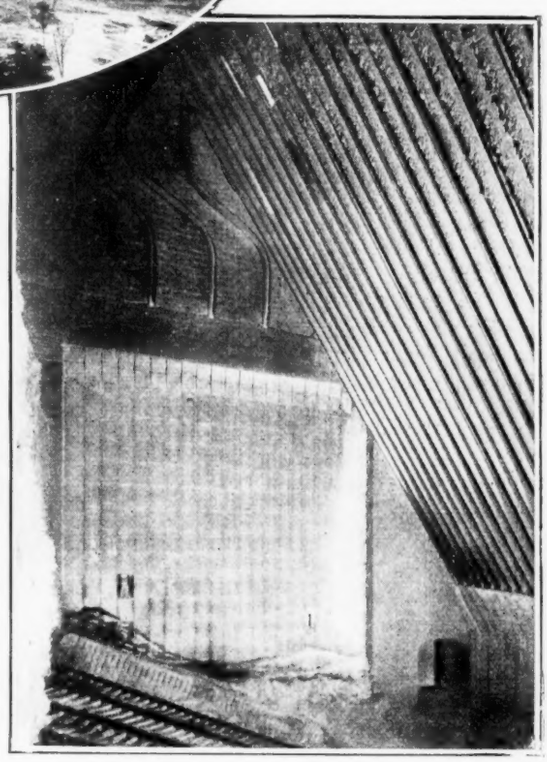
Below: Boiler control board



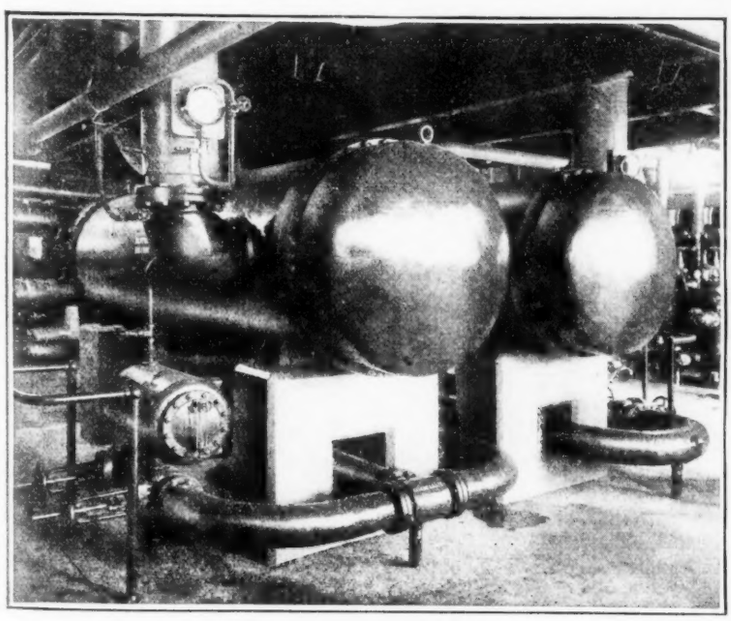
Saxton station as it now appears



Water screens are installed on both side walls and bridge wall



Bleeder heaters taking steam from 15th and 13th stages of turbine



How Frequency Meters Operate

By E. H. Stivender

CLASSIFICATION is made on the basis of operating principle, and typical instruments of each of four types are described. Both indicating and graphic recording meters are taken up.

THE frequency meter has become one of the most important instruments on power-plant switchboards, and a number of different types have been developed. This article deals with the instruments of four manufacturers, whose products are in general use. It has become common practice to install recording or graphic frequency meters in many plants to give accurate records of system conditions at all times, while indicating meters are almost indispensable when synchronizing, as their use saves much turbine-room signaling.

Frequency meters may be divided into four general classes: (1) Moving iron-vane type; (2) induction type; (3) electrodynamometer type; (4) vibrating reed type.

Moving Iron-Vane Type

Fig. 1 illustrates the principle of the Weston moving iron-vane type frequency meter. This instrument is constructed to operate similarly to a Wheatstone bridge. In the diagram coils E and F, which are mounted at right angles to each other, form the actuating element. The magnetic fields of these coils act upon vane G, which is pivoted inside the coils and to which the pointer P is fastened. Reactor A, coils F and E and non-inductive resistor C are connected in series and form one leg of the bridge. Resistor B and reactor D form the other leg. Reactor H, which is in series with the system, serves to damp out the higher harmonics which might have a slight effect on the scale reading.

The combined impedance of coils A and F is equal to that of coil E and resistor C at normal frequency; likewise, the resistance of B is equal to the reactance of D at that frequency. The torque produced by coil E is then equal to that of F, and vane G takes a position at 45 deg. to either actuating coil.

Should the frequency decrease, the impedances of coils A and D decrease while resistors B and C remain of the same impedance. Also A and F are of negligible reactance. Therefore, with a decrease in frequency, additional current flows through H, D, F, A, strengthening the field of F with respect to that of E. The vane G then takes up a position along the new resultant field, nearer in the plane of the flux of F, and the pointer P indicates the new frequency in cycles. With an increase in frequency the reverse action takes place. The field of F is weakened with respect to that of E, and the pointer moves in the opposite direction. This type of frequency meter does not have springs, hence the pointer will remain in position anywhere on the scale when the current is turned off.

Induction Type

The Westinghouse Co. uses the induction system, operating on the principle of a single-phase watt-hour meter, in its indicating frequency meters; the flux of the actuating coils sets up eddy currents in a metallic disk, tending to rotate it. In Fig. 2 the actuating coils A and B of the meter are energized through a reactor L and a resistor A respectively. Shading coils X and Y produce a rotating field, each tending to move the disk in opposite directions. As the frequency increases, coil A takes less current than B, causing an unbalance of the two torques, and B turns the disk. With a lowering frequency the opposite action occurs.

The current through B is unaffected by a change in the frequency of the circuit, as it is in series with resistance R only. The section of the disk controlled by B is a true semicircle, with the shaft at its center; hence the torque due to magnet M is constant at any position of the disk. The section of the disk controlled by coil A is a semicircle set off-center with respect to magnet L. Therefore when the disk moves in the direction of the arrow, which represents the direction in which the magnet L is pulling, the area acted upon by L is decreased. Movement in a direction opposite to the arrow causes an increase in the area acted upon by the magnet. Therefore, when coil B has a greater relative current, magnet M pulls the disk in such a direction as to cause the torque of L to increase and D comes to a new balance point. This construction of the disk eliminates

the necessity of a control spring which would otherwise be needed, as a circular disk moving on its geometric center would have a continuous rotary movement with a change in frequency, if not retarded.

Electrodynamometer Type

Fig. 3 is a diagram of a metering system for measuring slight changes in frequency and is much used in laboratory experiments. With this construction a change of 5

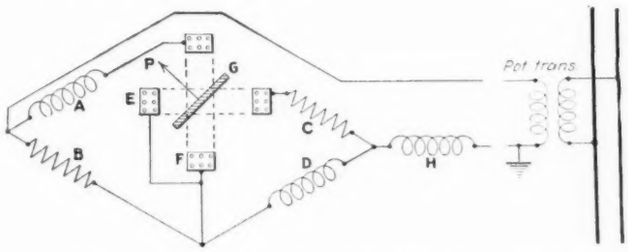


Fig. 1—Weston moving iron-vane type meter

cycles from normal frequency will give half-scale deflection on a 6-in. scale.

The circuit consists of three combinations, each tuned for a certain frequency and containing a condenser, reactor and resistor. The circuits containing C_1 and C_2 are tuned for approximately 36 and 58 cycles respectively, and are connected in multiple and in series with coil A of the moving system, while the circuit containing condenser C_3 is tuned for about 70 cycles and is in series with movable coil B, which is at right angles to coil A. The complete system is in series with the field coil F and contained inside it. The shaft is not at right angles to the moving coils, but set at an angle as in an inclined-coil voltmeter, or ammeter, in order to give a greater percentage of deflection for a given frequency change.

In operation, the movable coil which is contained in the circuit tuned nearest to resonance with the line frequency will produce the greater torque and tend to move in the plane of the field flux, which, owing to the

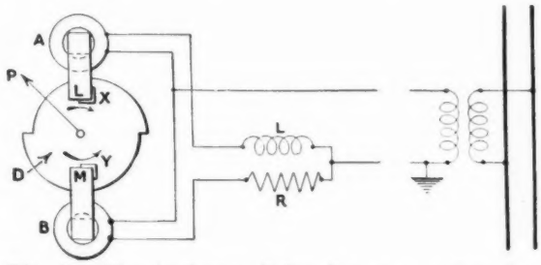


Fig. 2—Westinghouse induction type, using the principle employed in watt-hour meters

connection, is near synchronism with the line. The condensers, reactors and resistors are made variable for tuning.

The movable element is not retarded by a spring, as the torque tending to rotate it also holds it in place at the balance point until a change in frequency occurs.

Vibrating-Reed Instruments

The vibrating-reed instrument, a unit of which is shown in Fig. 4, is a sensitive instrument that has no rotating parts. Instruments of this type operate on the principle of the tuning fork, having a number of steel reeds fastened at one end and tuned to resonance at different periods of vibration. For commercial indicators the periods of adjacent reeds vary from one-quarter cycle to two cycles apart, depending upon the service to which the instrument is adapted.

In construction the actuating coil is wound on an iron core mounted in the vicinity of the reeds and in position to form a magnetic circuit through the reeds. The strength of the magnetic field is varied by an adjusting screw. This is done to give the reeds the length of travel desired and to eliminate an objectionable hum, depending upon the stability of the mounting board.

Some instruments have reeds of different lengths in order to obtain desired resonance, while others are made of the same length with solder weights on the ends to

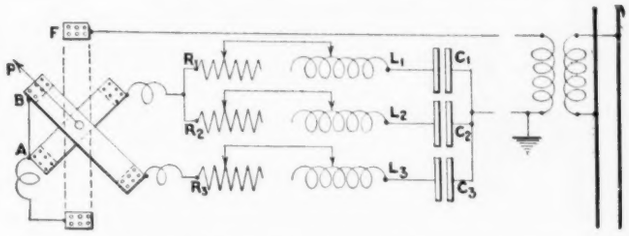


Fig. 3—Electrodynamometer type for precise measurements, especially useful in laboratory work

adjust the vibration periods. The vibrating ends of the reeds are bent at right angles and enameled white to enable the reed that is vibrating most to be readily observable.

Owing to harmonic effect, reeds that are not in resonance with the vibration of the electromagnet core may vibrate along with the one that is in full resonance. This causes a combination of several apparent white bands with the longest band indicating the frequency. Sometimes two reeds will vibrate equally, in which case the correct frequency would be halfway between them on the scale.

Instruments of this type are often used as tachometers on turbines and mounted rigidly on the frame of the unit, having their scales graduated in revolutions per minute. In this case an electromagnet is not necessary, and all electrical connections can be omitted.

Frequency meters of this type are made to operate directly on moderate low-tension line voltages with no

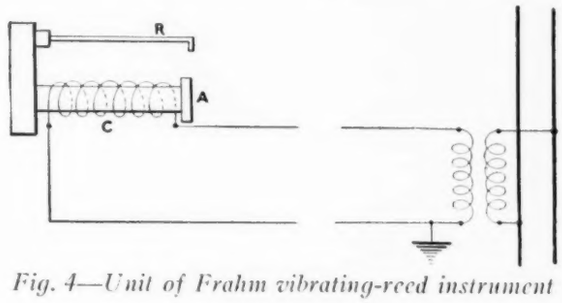


Fig. 4—Unit of Frahm vibrating-reed instrument

external resistors, as their electrical circuits do not require calibrating. Soft rubber pads on the back of the instrument case prevent the objectionable hum that would result from solid mounting.

Miscellaneous Types

In the General Electric Co. frequency meter of the induction type, known as the tuned-circuit instrument, a condenser and resistor are employed, while in another

a reactor and resistor are used. The instrument is adjusted to correct indications by rheostat arms on the side of the resistor-reactor box, which are then fastened in place with screws in order to prevent accidental movement. After once being adjusted correctly, the arms do not require further attention, as moderate load and voltage conditions have no affect on the accuracy of the readings.

These instruments have no control springs, and when they are properly mounted there will be no tendency of

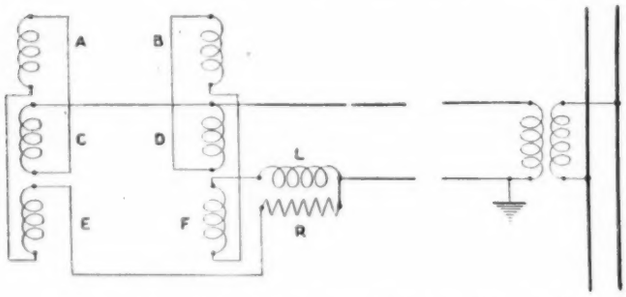


Fig. 5—Metering coil connections for the graphic recording apparatus in Figs. 6 and 7

the pointer to move when the current is discontinued. Potential transformers must be employed on voltages over 750.

Solenoid-Operated Graphic Meter

Fig. 6 is a diagram of the pen-control mechanism of a solenoid-operated graphic frequency meter. This instrument employs the dynamometer principle, in that it depends for its operation on the forces expected between coils with air cores. The coils are arranged to have very little travel, as the chart reading depends upon the tension of the control spring and not upon the distance the movable coils travel, as with indicating instruments. Fig. 5 shows the line and metering coil connections used in both solenoid- and motor-operated instruments.

A control spring is fastened to the pivoted yoke and to the pen-actuating yoke *G*. Counterweights are fastened on the opposite side of the pivot to oppose the action of the spring. Both the position of the spring and that of the counterweights are adjustable for calibration when the instrument is placed in service. At normal frequency coils *C* and *D* are respectively midway between coils *A* and *E*, and *B* and *F*. Also movable contact *K* is midway between stationary contacts *L* and *M*.

Referring to Fig. 5, coils *B*, *D* and *F*, forming one control element, are in series with reactor *L* and therefore responsive to frequency changes. Coils *A*, *C* and *E* of the other element are energized through resistor *R* and are independent of frequency variations. The sets of coils are connected so that there is attraction between the movable and stationary coils on one side and repulsion on the other side, producing twice the torque possible under the same conditions if only one stationary coil were used for each movable coil.

In operation, with a decrease in frequency from normal, coils *B*, *D* and *F* in the reactor circuit take more current and unbalance the torque on yoke *J*, closing contacts *K* and *L*. This completes the solenoid circuit *1*, *Y*, *L*, *K*, *2*, causing *Y* to pull its plunger down and by means of lever *G* draw the pen across the chart. Immediately, a tensile strain is put on the helical control spring *S*, which tends to open contacts *K* and *L*. The force required to do this is proportional to the change in frequency; hence as *G* moves sufficiently to produce the corresponding tension in spring *S*, pencil *P* moves over the chart a distance proportional to the change in frequency.

With a rising frequency the torques of *A*, *C* and *E* become relatively greater and close contacts *K* and *M*, completing circuit *1*, *X*, *M*, *K*, *2*. The plunger of *X* then moves the pen in the opposite direction to that of the preceding explanation and allows the counterweight to overcome the action of the control spring and torques of the metering coils until contacts *K* and *M* open at a balance point proportional to the new frequency.

The dimensions of the pen-actuating members are so made that *P* moves in guide *O* in such a manner as to make the point travel in a horizontal line across the chart, permitting the use of standard cross-section paper.

Mechanical adjustments to be made are the positions of the counterweight and the upper end of the control spring. The counterweight should be adjusted to bring the reading to normal when the metering circuit is off but the control circuit left on. Moving the position of the upper end of the spring toward the pivot tends to make the readings at the ends of the scale farther away from normal frequency readings, while moving it away from the pivot tends to bring them closer to normal reading for the same frequency value.

The electrical adjustment is a series variable resistor supplied with voltage markings corresponding to standard average system voltages. As the reading is normal when the metering circuit is off, variation of this resistance does not affect the reading at or near normal frequency, nor does a change in line voltage affect the reading at this position.

The resistors *T* and *U* act as discharge circuits to

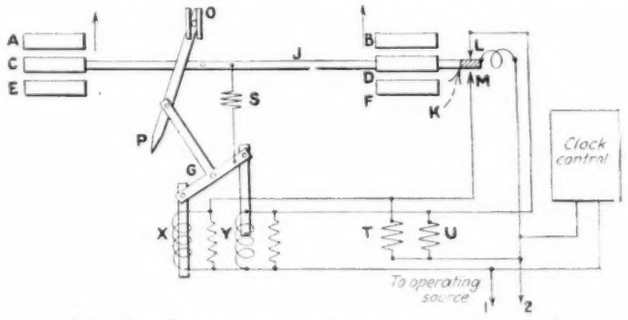


Fig. 6—Arrangement of pen-control circuit in solenoid-operated recording meter

prevent excessive arcing at the contacts *M* and *L*. The resistors across *X* and *Y* are not used on control circuits of frequencies below 60 cycles. Potential transformers are required on circuits above 125 volts. A clock winding switch automatically closes a motor circuit which winds the clock regularly, as in the Western Union system.

Motor-Operated Graphic Meters

Graphic frequency meters of the motor-operated type depend on the same metering circuit construction as solenoid-operated instruments, but their pen-control circuit is different. The contacts serve to reverse the field of a small series motor which operates the pen by means of screw *J* and traveler *X* in Fig. 7.

As the frequency decreases, coils *B*, *D*, *F* close contacts *K* and *L*, completing the motor circuit *1*, *O*, *H*, *R*, *K*,

L, *2*, which starts the motor, causing *X* and *P* to travel along the shaft *J* and the chart. As this occurs, *X* turns spiral *S*, increasing the tension on the control spring until the contacts open, which takes place when *P* is at a distance from normal proportional to the change in the frequency of the circuit being metered. With an increase in frequency the control circuit will be *1*, *O*, *M*, *K*, *R*, *I*, *2*, which energizes the field in the opposite direction. The motor moves the pen the other way, indirectly tending to open contacts *K* and *M* and stopping the motor. Resistors *T* and *U* provide discharge circuits for contacts *L* and *M*.

A chain drive is employed between the motor shaft and *J* for moving the pen. The motor can thus be mounted in the rear and the screw in front, bringing the chart nearer the face of the instrument case. The clock control is the same as for solenoid instruments.

Operating Notes

Potential transformers are shown in all diagrams, as practically all modern equipment uses them where switchboard instruments are operated at voltages above 500. The secondaries of all instrument transformers should be grounded at the transformer to insure against high voltages on the secondary leads in case of insulation failure inside the transformer. Electrostatic induction is also often present to an appreciable degree at high primary voltages, and should be neutralized by using secondary ground.

The manufacturers recommend grounding the cases of all instruments used on grounded secondary transformer circuits in order to make the cases of the same potential as the operating parts. However, many switchboard wiring diagrams do not call for instrument case grounds in order to eliminate complication and expense in wiring as much as possible.

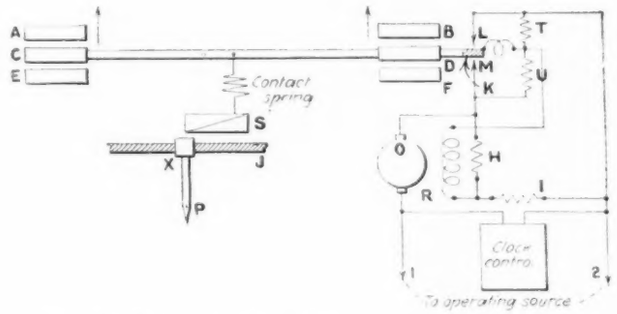


Fig. 7—Pen-control mechanism in motor-operated recording meter

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As a Result of a Survey made by the Rural Electric Service Committee of the National Electric Light Association, it is reported that 227,442 farms in 27 states were receiving electric light and power service on Jan. 1, 1927. On Jan. 1, 1924, it was reported that 121,854 farms in these 27 states had service. This is an increase of 86.6 per cent in three years. On this basis it is estimated that between 300,000 and 350,000 farms in the United States are receiving electric service from distribution lines. There have been 227 uses listed for electricity on the farm and 190 uses for rural industries. —*C.R.E.A. Bulletin.*

What Do You Know?

The answers are on page 177

A DOCTOR, in case of doubt, can always avoid a wrong decision by calling a consultation. The lawyer does not blush in asking a continuance while he looks up the law in the matter. The engineer is not so fortunate and is expected to give an answer to an engineering problem almost right off the bat. He must carry in his mind most of the basic laws upon which his profession rests. How much are you carrying around? Can you answer the ten questions listed below; that is, correctly? Answer them and then turn to page 177 to see how the editor solves them.

Ques. 1—Knowing the number of poles in an alternating-current generator and the speed at which it operates, how is the frequency of the machine calculated?

Ques. 2—Why are flexible staybolts used in firebox boilers?

Ques. 3—With a constant boiler efficiency will a given amount of coal evaporate more pounds of steam at 150 lb. than at 10 lb., with feed water at 212 deg. F.?

Ques. 4—How would you proceed to free oil-engine piston rings that were stuck fast?

Ques. 5—Is there any advantage in a steam dome on a fire-tube boiler?

Ques. 6—Where should rim joints be located in thin-rim flywheels?

Ques. 7—Why is the portion of a crankshaft between bearings made heavier than the portions resting in the bearings?

Ques. 8—A shaft 5 ft. long weighs 5,000 lb. In lifting, a sling is fastened to each end of the shaft and the crane is hooked to the middle of the sling. Is the pull on each end of the sling one-half the shaft weight? Why?

Ques. 9—If a plant is at a level where the atmospheric pressure is 13.85 lb. per sq.in., what is the pressure tending to collapse a cylindrical tank in which a vacuum of 24 in. of mercury is carried?

Ques. 10—If a vapor in the pressure of the liquid exerts a pressure corresponding to the temperature of saturation of the liquid, is it possible to have liquid ammonia in a condenser at a temperature below the temperature corresponding to the pressure of the vapor?

JOHN HUNTER
Consulting Engineer, St. Louis, Mo.

Making a Drive on Smoke

The City of Nashville, Tenn., reports remarkable progress during first year in the development of its program for smoke abatement and prevention.

THAT a great city can, if it so decides, plan and successfully carry on a definite program of smoke abatement and prevention is evident from the facts presented in the Smoke Abatement Report recently made by John Hunter, consulting engineer, to the Smoke Abatement Commission of Nashville, Tenn. Although the report covers a period of only the first year of activity, the definite accomplishments indicate that the program has been carefully worked out and planned on a logical and practical basis.

Perhaps the outstanding feature of the Nashville program was a realization at the beginning that the abatement and prevention of smoke in a municipality is primarily a human problem and not entirely an engineering one. Another interesting fact is that the initiative in the move for smoke abatement in Nashville was taken by a group of citizens, which demanded some action from the city government on the smoke problem. This situation resulted in the appointment of a Commission of Engineers to investigate the local situation and to find and suggest a remedy.

The Commission, after a thorough study of the situation, advised the passage of a smoke ordinance, the organization of a Smoke Abatement Department and that an engineer, thoroughly competent and experienced in the combustion of fuels and smoke abatement, be selected to organize the department and set it in motion. These suggestions were followed, and John Hunter, consulting engineer, of St. Louis, was selected to do the preliminary work outlined by the Commission.

At the beginning of the campaign for smoke abatement definite efforts were made to bring the case clearly before the people. In order to do this, articles of general interest to the public, as well as to those specifically concerned with smoke prevention, were prepared for the press as a part of the plan to educate the people regarding the actual facts of the case. Lectures and talks were also given before various civic organizations and groups, and advertising was done in the press.

Mr. Hunter lost no time by making elaborate smoke determinations in the city, but started immediately on the actual program of reducing the smoke, basing his expectations on the experience of other cities.

Attention was first given to the high-pressure plants in the heart of the commercial and industrial district. Investigations were conducted and suggestions made concerning the changes necessary to make smokeless operation of these plants possible. About 80 per cent of the boilers in this service were found to be of the horizontal return tubular type, the other 20 per cent being water-tube. In these plants smoke reduction was brought about by the installation of stokers, air jets, air blocks, brick piers and arches, as well as by making the necessary repairs to breechings and flues. Definite recommendations were also made as to the best kind and size of fuel to be used and the best method of firing it.

It was found difficult, when stokers were recommended, to convince plant owners of the economies of smokeless operation of these units. It was found somewhat easier to induce the owners to install air blocks and air jets first. After discovering the advantage of this equipment, some were more favorable to the installation of underfeed stokers as recommended in the first place.

During the first four months 150 of the larger high-pressure plants were surveyed. A permanent record of each plant was made and the record put on file in the office of the Smoke Inspector.

The investigation of the smaller high-pressure plants found extensively in steam shovels, hoisting engines, small laundries, creameries, hotel kitchens and in cleaning and pressing equipment, showed the boilers to be generally of the vertical or locomotive type with combustion chambers much too small for the smokeless combustion of high-volatile coal. It was found necessary, therefore, to recommend the use of a smokeless fuel in this type of equipment, as it was learned, by experience, that it would be impossible to prevent objectionable smoke by any other means.

Among the types of equipment in the industrial and commercial plants were found many boilers and furnaces of the down-draft type. Although this type of equipment, when in good repair and when fired properly with suitable fuel of the correct size, proved to be the best for burning high-volatile fuel with the least amount of smoke, the investigation found much of the equipment of this type in bad repair and with the fuel being fired on the lower grate. It was necessary to put these furnaces in proper condition and then to give very specific directions as to the proper method of firing and the size coal to be used. Although lump or mine run had to be used in some plants, others were able to use slack without any particular difficulty.

With the beginning of the heating season attention was directed toward the larger heating plants in office buildings, apartments, stores, etc. Approximately 500 of these were surveyed and specific recommendations made. In spite of the large number of these plants a separate report was written on each one and a record made of just what was done by the plant owner. This also furnished the department with information regarding plants where it might be found necessary at a later time to exert pressure in order to get some action.

Where low-pressure down-draft furnaces were used for heating, it was found necessary only to suggest the necessary repairs and to give instructions on the fuel and method of firing. As previously pointed out this type of equipment was found to be one of the best mediums, outside of stokers, in the prevention of smoke.

Many of the low-pressure boilers used for heating purposes were found to be old horizontal return-tubular types, set very low, with brickwork in bad condition and leaking badly, and with low stacks producing poor draft. In fact, the conditions in most plants were ideal for poor combustion and the production of smoke. Being set in low basements and on rock foundations, it was found almost impossible to make the necessary changes unless at great expense. Also, because of the low pressures available, air or steam jets could not be used. Consequently, the only solution was the use of coke which was used both successfully and economically in many such plants. Some underfeed stokers, however, were installed where it was found possible to do so.

In many of the newer office buildings, hotels, etc., heating boilers of the so-called super-smokeless type were found. The investigation pointed out that most of these smoke badly at times of firing. Tests made demonstrated that it is impossible to keep the smoke produced from this type of equipment within the ordinance requirements of No. 2 on the Ringlemann Chart, when a coal of over 25 per cent volatile matter is used. The coal used in Nashville has 40 per cent volatile matter, consequently this type of equipment, as installed, could not be operated under satisfactory smoke conditions. The use of coke, however, in these boilers was suggested and has been very satisfactory. No new installations of this type of boiler are to be permitted unless the improvements necessary for smokeless operation are made by the manufacturer.

It was realized, of course, that the railroads were responsible for a considerable part of the smoke produced in the city; consequently, the interest and co-operation of the proper officials was necessary. This was readily attained, as it was quite evident that the production of smoke was an economic waste and its prevention represented a distinct saving to the railroads. Copies of the Smoke Ordinance were circulated among the locomotive engineers and firemen and their co-operation solicited. Special instructors and inspectors were assigned by one road to instruct the firemen in the best methods of firing for the prevention of smoke. This road, incidentally, reports a fuel saving of about 25 per cent during the year, a portion of which can be credited to the efforts toward smoke prevention.

At the round house of another road, some demonstrations were made and instructions given on starting fires. A method of starting the fires from above the green coal with oil torches was adopted in place of the old method of starting the fire by placing the green coal on top of the kindling. The adoption of this plan of firing has resulted in a material reduction of the smoke produced.

Another phase of the problem consisted in efforts to stimulate an interest in and a demand for smoke reduction from residence furnaces. This, usually, is a difficult problem to solve, as so many different individuals must be convinced of the merits of smoke prevention, as well

Some Important Thoughts on Smoke Prevention

By John Hunter

"SMOKE is a civic liability. Smoke abatement is a civic problem, a problem in which every citizen and civic and commercial organizations concerned with the making of a better and greater city should be vitally and constructively interested.

Smoke abatement should be considered by the municipality a housekeeping job and the department maintained with as much consideration and effort as sewage disposal, clean streets and pure water.

Perhaps the largest factor in the problem of smokeless combustion is the human element of operation and control.

Offenders in the costly and unnecessary production of smoke have had it demonstrated to them that smoke is the result of improper combustion.

The question is not what *can* be done about it, but what do you as individuals want to do about it. A community gets just as much law enforcement as it desires. Until each member of the community realizes his individual responsibility and does what he can to make his own chimney smokeless, no permanent improvement is possible.

Teaching a city to be sensible is a tremendous task, but the results obtained show that it is well worth while.

Knowledge of the proper methods to use, and intelligence and care in their application are the ultimate to be desired.

Education plus co-operation spells success in Smoke Abatement."

as given instructions as to how it can be done. Special lectures, therefore, were given at the grade schools for the purpose of instructing residence owners as to the proper method of firing their furnaces with the least amount of smoke. In addition cards containing instructions were printed and distributed to the residences by the Boy Scouts. Classes for the instruction of colored firemen and janitors were also productive of good results, nearly 100 receiving certificates of merit.

Generally, no consideration had been given, in the manufacture or operation of the domestic heating equipment found installed in Nashville, to the elimination of smoke. This made the situation difficult for the reason that it was found practically impossible to use the high-volatile coal available without excessive and objectionable smoke. Coke was recommended as a fuel for this type of equipment, which it has been found will burn coke better than coal, at about the same cost, with less labor, dirt, soot and ashes and without smoke.

Although gas and oil are used to some extent, these fuels were not especially recommended because of their high cost in comparison to coke. It will be desirable to consider the additional use of this equipment, especially by those who can afford it.

The Use of Coke

An interesting fact brought out in the early part of the investigation was the apparent non-co-operative attitude of the coal dealers to the smoke abatement campaign

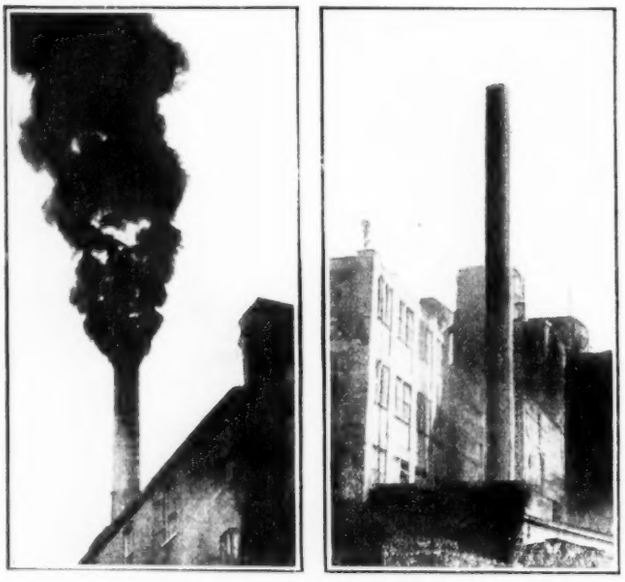


Fig. 1—Some of the Results

Stack from two 300-hp. B. & W. boilers with vertical baffle. Underfeed stokers smoked badly when fires were being cleaned. Air pipes were installed over fires with ¾-in. steam jet to be used when cleaning fires. Left view—Cleaning fires without air jet. Right view—Cleaning fires with air jet on.

in general and to the recommendation that coke be used in particular. This situation was typical of the difficulties sometimes encountered in a campaign of this kind. As usual, however, a complete understanding of the problem brought a change in attitude on the part of the coal dealers, with the result that coke is now being pushed as a domestic fuel, especially in those plants where it was found impossible to burn the available soft coal without objectionable smoke. In addition, the co-operation of the dealers was obtained in an effort to have each type of furnace supplied with the best type of fuel.

Appointment of Smoke Inspector

In keeping with the original recommendation of the Commission of Engineers, a competent smoke inspector has been obtained and will continue the work for which the foundation was laid by Mr. Hunter.

In commenting upon the future of smoke prevention in Nashville, Mr. Hunter makes the following remarks:

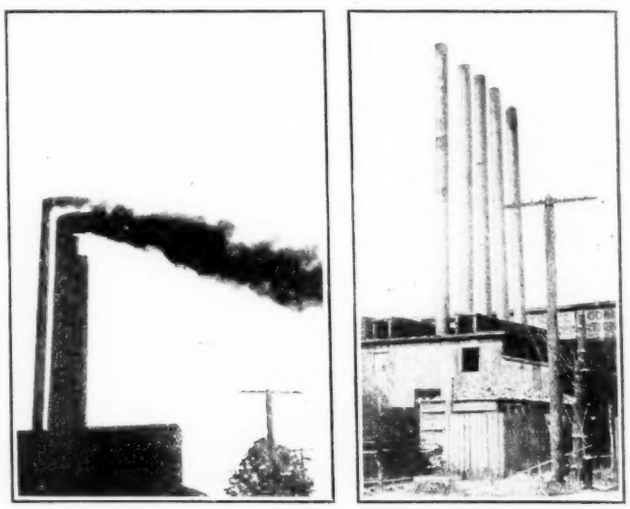


Fig. 2—Improvement in Hand-Fired Plant

Ice plant with five 200-hp. h.r.t. boilers with hand-fired straight grates set 4 ft. 6 in. from floor. Smoked badly during firing periods. Five 2½-in. air pipes were installed with ¾-in. steam jets for reducing high velocity air over fire. Left view—Firing with jets off. Right view—Firing with jets on.

"Smoke abatement is not a matter that can be settled overnight and then left to take care of itself without attention, but is something that must be watched year in and year out if high standards are to be maintained. It will be the particular business of the smoke inspector, with the assistance and backing of the Smoke Abatement Committee, and Mayor and the Board of Public Works, to see that smoke is eliminated from Nashville. This is not a question of observation of smoking chimneys and prosecution of offenders, but intelligent organization of sentiment in favor of smoke abatement, assistance and service rendered in the approval of plans of all new equipment before it is installed, and in the proper operation and maintenance of old and new equipment. This work deserves the approval and support of every intelligent citizen, as it is a work directed in the best interests of the majority. Until the public is thoroughly aroused, demands smoke abatement and shows continued interest in it, no permanent improvement is possible and the efforts of one man, no matter how sincere, capable and energetic, will be of no avail."

The results accomplished in Nashville, in the comparitively short period of a year, should be of particular interest and value to those cities, regardless of size, which have a smoke problem. Mr. Hunter has proved that a good start on the abatement and prevention of smoke can be made and much beneficial work done in a short time, provided the community really wants to solve its smoke problem and makes use of the proper methods to solve it.

Reduce Ice-Making Costs by Better Apparatus and Installations

By C. T. Baker

ONE thing may be taken for granted in these days of domestic electric refrigeration and that is, the price of ice is not going to increase. The ice manufacturers, if they expect to maintain a safe ratio of net profits, can no longer permit their plants to be operated by guesswork, nor can they permit structural defects or defects of design to exist when such defects impair efficiency and affect output.

The public will not tolerate, except perhaps in a few isolated cases, increases in the price of ice and, if anything, will demand lower prices as time goes on. Therefore it may be safely stated that ice-production costs must be carefully controlled if the manufacturer is to continue to make reasonable returns on his investment.

The writer has had the opportunity of investigating quite a number of ice plants that have not been producing economically and has come to the conclusion that an uncomfortable percentage of plants operate inefficiently and cannot hope to show a better performance until the present machinery is rearranged or new equipment installed.

An extreme example of defective engineering is a plant that, as originally installed, consisted of a high steam pressure absorption distilled-water ice plant of about 15 tons daily capacity, which the owners later decided to change to raw-water ice. The plans included using the original tank and as much of the old equipment as possible, except that as electrically driven compressor was to replace the generator and absorber of the original installation.

The tank was equipped with 1-in. evaporating coils arranged for top feed and bottom gas outlet and provided with 280 ice cans 14 in. square by 39 in. deep, rated at 200 lb. each.

Some Omissions

When the change was made from distilled to raw water, one small propeller of the horizontal type was installed to circulate the brine in the freezing tank, but unfortunately only one partition was installed to direct the flow of brine. Since the tank was approximately 30 ft. long and the partition was run across the narrow way of the tank, making two 15-ft. brine passages, the circulation was sluggish and short-circuiting of the brine was noticed at several points. To make matters worse, no liquid trap or accumulator was placed on the suction outlet near the tank for trapping the liquid back to the evaporating coils, as it was thought that taking the suction gas through the cooling coils in the original distilled water forecooler would prevent liquid reaching the compressor. It was supposed that the water, in passing around these coils to the can filler, would evaporate any entrained liquid in the suction gas.

In this particular case, however, the water forecooling tank was 15 ft. high and equipped with 2-in. coils divided into three sections, but all connected in series. The result was that all the suction gas had to pass through all the coils, causing a decided pressure drop between the freezing tank and the compressor with a loss in compression efficiency.

When a careful check was made, it was found that this pressure drop in the suction gas amounted to exactly 6 lb., and while no great amount of trouble was experienced from liquid reaching the compressor, the method of preventing such trouble was quite expensive, to say the least, for the machine installed was a fairly large one, having two 12-in. diameter by 20-in. stroke compressor cylinders operating at 60 r.p.m.

The additional weight of ammonia that could have been pumped by removing this 6-lb. pressure loss would be quite an item in a year's time and would represent quite a saving in power, to say nothing of the additional capacity that would result.

No Oil Tank Installed

In making the change-over from the original absorption system, no provision was made for drawing oil from the evaporating coils in the freezing tank, consequently it was not possible to keep these coils free from such oil as invariably finds its way from the compressors to the evaporating system.

An examination of the atmospheric ammonia condensers disclosed a very poor arrangement of condensing water distribution; only 75 per cent of the water pumped was doing useful work. To make matters worse, the condensers were not cleaned regularly and were found heavily coated with heat-insulating deposits. The result of these unfavorable conditions was reflected in a condensing pressure of 210 lb. gage.

The conditions as described were discovered recently, and nothing can be done to help matters much until the present ice season is over, which means several months' operation with loss of capacity and high power costs, both of which decrease the plant's profit.

In another instance a small refrigerating plant in an office building had been experiencing trouble with high condensing pressures, and the management complained of high power costs. An investigation disclosed that the double-pipe ammonia condensers were quite heavily coated on the water side with deposits from the condensing water. It was found that the water outlet from these condensers was piped to the compressor jacket with the outlet from the jacket so small that it was not possible to pass enough water through to take care of the condensing requirements even with clean condenser tubes.

Water System Changed

Changes were ordered made in the water-piping system so as to provide an independent supply of water to the condensers and compressor jacket. The system was purged of non-condensable gases, but it was discovered that it was physically impossible to scrape the condenser tubes, for each end of the condensers was within 14 in. of a brick wall with no room to insert a scraper for cleaning. Should a tube ever develop a leak, it will be necessary to remove the condensers to make repairs. For a number of months the condensing pressure has been running at 240 lb. gage with the inlet condensing water at 70 deg. F.

In both of these cases the inefficiency of the installation was such that the operating engineer was handicapped in his attempt to manufacture ice cheaply. If the household machine performs no other mission than forcing the installation of economical apparatus, its existence will be justified.

Correction—H. W. Queisser is the author of the article, "What Capital Expenditure Is Justified by Thermal Savings?" appearing in the July 26 issue. *Power* regrets that his name was inadvertently omitted.

Heat Rates for Steam Power Stations Compared

By P. H. HARDIE*

A DEFINITE conception of the thermal economy to be expected from well equipped steam power stations with diverse equipment and designed for pressures from 200 to 1,200 lb. is obtainable from the curves accompanying this article.

A LARGE AMOUNT of literature has been published in recent years dealing with the gain in economy due to high pressures, regenerative feed heating, resuperheating, and extracting the heat from the flue gas by means of economizers or air preheaters. Many of the articles and treatises in technical magazines

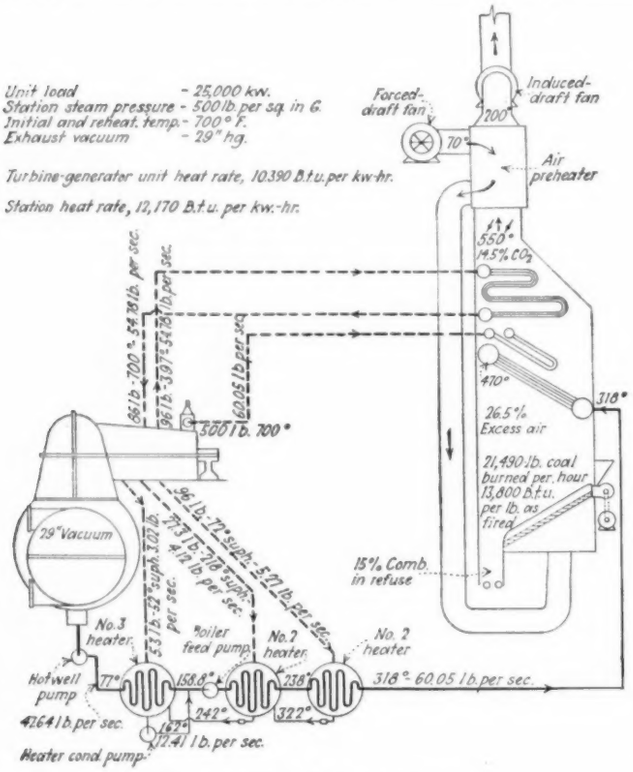


Fig. 1—Heat-balance diagram

For a steam power station with three stages of regenerative feed heating, with reheaters and air preheaters, without economizers and with motor-driven auxiliaries.

and books have been, and still are, of inestimable value to engineers. Notwithstanding all that has been previously published, comparatively few steam engineers have a true mental conception of the gain in thermal economy due to increasing the steam pressure, changing the character of the cycle, adding fuel-saving equipment, or a combination of all three which has been the general practice in recent years. This is mainly due to the fact

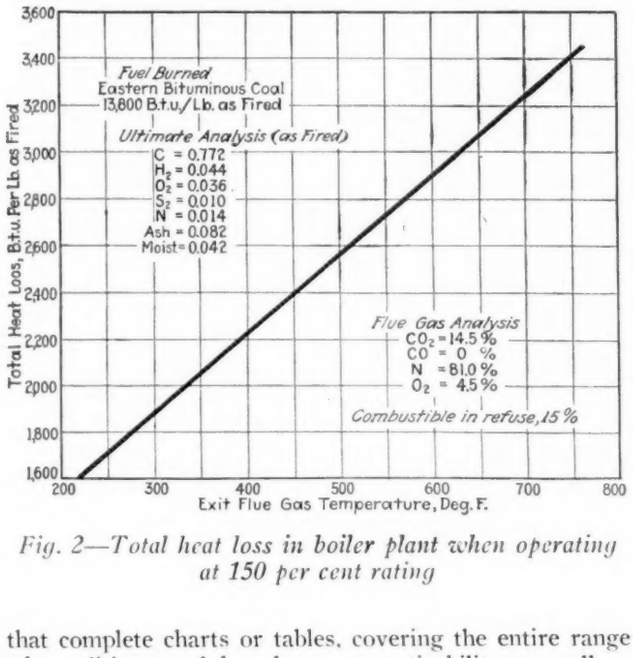


Fig. 2—Total heat loss in boiler plant when operating at 150 per cent rating

that complete charts or tables, covering the entire range of conditions and based upon practicability as well as theoretical possibility, are not available to the engineering profession in general.

It is of interest to note some of the interlinking conditions which impose themselves upon the steam power station designer. Often engineers are led astray by theoretical gain or by improvement due to changes in one part of the cycle or system without considering the limitations imposed thereby upon the remaining equipment. Take, for instance, increase in steam pressure, which improves the economy of the turbine, but which increases the temperature of the flue gas leaving the boiler, thus decreasing the boiler efficiency, assuming no economizer or air preheater. The auxiliary power also increases with the increase in pressure, and this offsets part of the gain due to improved turbine economy. Similarly, regenerative feed heating, which improves the heat rate of the turbine, also reduces the heat recovery ability of an economizer, which in turn reduces the efficiency of the boiler plant, all other conditions remaining constant. In the latter case a big field is opened for air preheaters which can reduce the flue gas to even a slightly lower temperature than was previously obtained with the economizer, the heat extracted from the flue gas being just as useful in heating the air supplied for combustion as in

*Assistant engineer, Research Bureau, Brooklyn Edison Co., Inc.

increasing the temperature of the feed water, since both must be heated in any case.

Although this article excludes all except the purely thermal factors involved in the generation of electric energy by means of steam-driven prime movers, it is recognized that the investment cost, operating costs and the ease and reliability of operation, should be included when selecting power station equipment. This involves a study of the load factor to be expected over a period

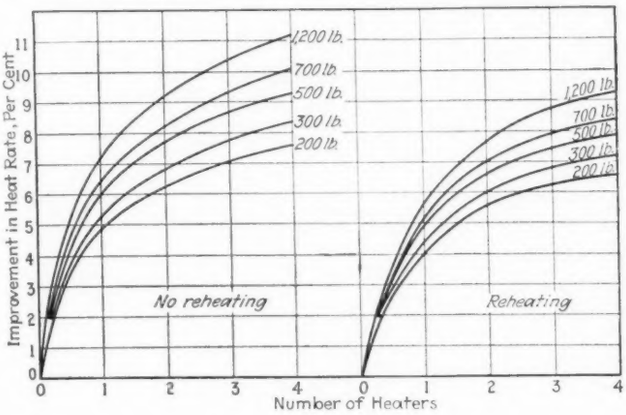


Fig. 3—Improvement in turbine-generator heat rates over straight condensing operation due to regenerative feed heating

equal to the useful life of the equipment. New units, by reason of their better economy, are generally considered as base-load units and are assigned a high load factor, thereby justifying their design for best economy at maximum load and also justifying the installation of expensive fuel-saving equipment to obtain small gains in economy. But the base-load units of today become the stand-by units of tomorrow with low load factors, and it is entirely possible that the carrying charges on the equipment during this period may overbalance the gain during the earlier life of the units. This, however, is a special problem for each operating company to solve for itself, as it involves not only the economic conditions, but also the policy of the management with respect to methods of operation.

Equipment Considered

For computing the heat rates the main equipment was assumed to consist of 30,000-kw. turbine-generators, each served by three water-tube boilers and one surface condenser. Various other equipment, such as regenerative feed-water heaters, economizers, air preheaters and reheaters, have been included for the different arrangements, with all auxiliaries motor driven. The boilers are assumed to be operating at 150 per cent rating and to be fired by underfeed stokers which burn Eastern bituminous coal of the heating value and ultimate analysis given on Fig. 2. The turbines are assumed to be operating at their most efficient load of 25,000 kw. and to be supplied with steam at the throttle at a temperature of 700 deg. F. and pressures varying from 200 to 1,200 lb. and exhausting to the condenser at 29 in. vacuum. The other operating conditions are given in Fig. 5. The equipment and operating conditions assumed have been selected so as to conform as nearly as possible to the best present-day practice.

To compute the size of all of the equipment, which is customarily expressed in square feet of surface, would necessitate the selection of heat transfer rates. Heat transfer rates depend upon so many variables that it was thought best not to assume any values, but merely to assume that the size of all the apparatus will be correct so as to produce the specified operating results under the assumed conditions.

A heat-balance diagram for one of the arrangements is given in Fig. 1. This arrangement includes most of the main equipment, with the exception of an economizer, that is at present used in steam power stations, and it shows schematically their respective locations with the connecting piping and ducts.

It also shows the temperatures, pressures and flow rates used in calculating the station heat rate for this particular combination of equipment.

From Fig. 2 the heat loss in the boiler plant can be determined for any exit flue-gas temperature and 14.5 per cent carbon dioxide.

Fig. 3 gives the percentage gain over straight condensing operation due to regenerative feed heating with one to four stages, for both with and without reheating. These curves show clearly that the increment of gain due to regenerative-feed heating decreases as the number of stages increases. They also show that there is less gain due to regenerative feed heating with reheating than without reheating.

The heat rates for the turbine-generator unit are given on Fig. 4 for all the arrangements considered, plotted against initial steam pressure. The values in the figure include no auxiliary power, and they are calculated assuming no makeup feed water. They are approximately the same heat rates that turbine manufacturers would guarantee at the most efficient load for turbines of the size here considered.

The final curves, Fig. 5, give the power station heat rates for all the arrangements considered. They are based on continuous operation at 100 per cent load factor,

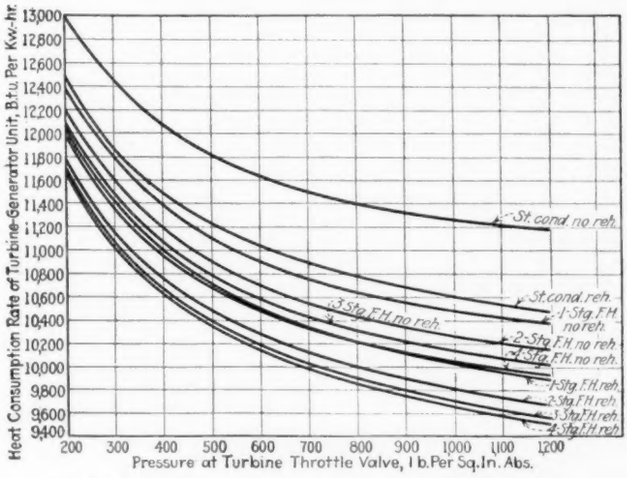

Heat Consumption Rate of Turbine-Generator Unit, B.t.u. Per Kw.-hr.
St. cond. no reh.
St. cond. reh.
1-Stg. F.H. no reh.
3-Stg. F.H. no reh.
2-Stg. F.H. no reh.
4-Stg. F.H. no reh.
1-Stg. F.H. reh.
2-Stg. F.H. reh.
3-Stg. F.H. reh.
4-Stg. F.H. reh.
Pressure at Turbine Throttle Valve, Lb. Per Sq. In. Abs.

Fig. 4—Heat consumption rate of a turbine-generator unit

and therefore they do not include banking losses. Neither do they include such auxiliary power as station lighting and heating, fresh and salt water service, compressed air, etc., but all auxiliary power that is directly chargeable to the main equipment is included. In order to determine the over-all station heat rates to be expected for normal operation conditions, the values in Fig. 5 must be increased by about 15 or 20 per cent, but of course these percentages are only very approximate, as the load factor, which is the main determining factor, varies considerably

for different power stations. The thermal efficiency can easily be determined when the heat rate is known, by merely dividing 3,412 by the heat rate.

It should be appreciated that in an attempt of this nature to give the heat rates for steam power stations it is impossible to include all the various arrangements. It is believed, however, that Fig. 5 includes most of the important equipment, cycles and pressures in use in modern steam power stations. Some of the arrangements that have not been included are, air preheating with steam extracted from the main turbine, reheating with live steam, and feed-water heating with the exhaust steam from the steam-driven auxiliaries. These are special cases and therefore have been omitted.

It is clear from an inspection of Fig. 5 that in order to obtain any appreciable benefit from high steam pressures (above 700 lb.) it is necessary to include some of the following equipment in the power station: Economizers, air preheaters, regenerative feed heaters and reheater. The more of these included, the greater the thermal gain due to high pressures.

The improvement in thermal economy that may be obtained by the addition of various equipment may be easily determined by comparing the heat rates shown by the curves in Fig. 5. Then if the load factor is known, it is not difficult to decide whether the thermal gain is sufficient to pay for the cost of its installation. Thus these curves may be used as a basis for determining the equipment that may justifiably be included in the plant layout.

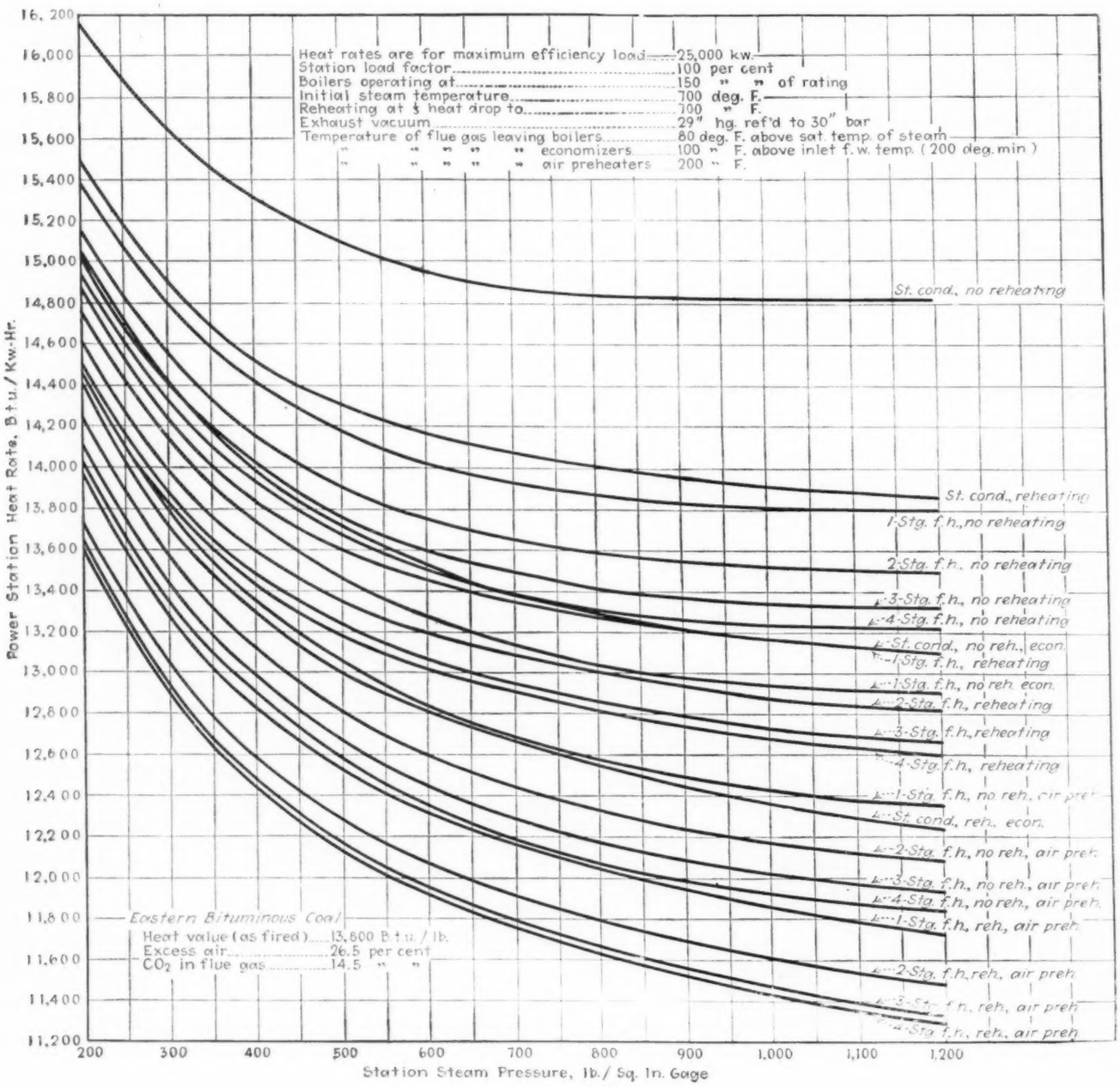


Fig. 5—Steam power station heat rates

For a station equipped with 30,000-kw. turbine-generator units and having various combinations of regenerative feed heating, reheating and extraction of heat from the flue gas by means of economizers and air preheaters.

Are Spare Units Needed in Oil Engine Plants?

THE author claims users are penalizing themselves by installing stand-by units, claims engines are as reliable as purchased energy and cites records to prove his point.

By EDGAR J. KATES
Consulting Engineer, New York City

A QUESTION that frequently arises when an oil-engine power plant is under consideration is whether a spare engine should be installed. The cost of such an engine is a large item. Whether the extra investment is justified depends not only upon the reliability of the engines to be used, but also upon the nature of the service and the number of engines in the plant.

COST OF BREAKDOWNS

The cost of shutdowns varies greatly in different services. For example, on an oil pipe line working at full pumping capacity, even a short interruption entails a

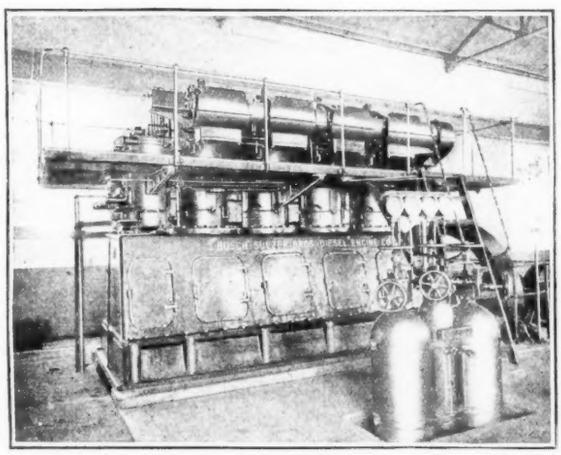


Fig. 1—A 400-hp. engine on pipe-line service with no stand-bys

heavy loss. If a 20,000-barrel line, pumping oil worth $1.25 a barrel, ceases operations for only an hour, $1,000 worth of oil does not get to market. A week's shutdown would involve a loss in output of $175,000. In an ice plant a midsummer stoppage is usually a costly affair. On the other hand, there are industries where power constancy is not so important. A case in point is a modern quarry completely equipped with labor-saving machinery and employing only a few men. This quarry carries a large storage of finished products, and a few hours loss of power is of little consequence to the business.

Power production, like any other human undertaking, can never quite reach perfection—there is no such thing as 100 per cent reliable power. This is true not only of the machinery in one's own power plant, but also of purchased electricity. Electric current at the consumer's meter is the last step in a long train starting with the generating station, followed by long-distance transmission at high tension and local distribution at moderate voltage. All these steps are subject to derangements.

RELIABILITY OF ELECTRIC SERVICE

The generating parts of power systems as a whole are now highly reliable because of the numerous units that can feed into the same power lines and the many safeguards that are employed. Nevertheless, occasional outages of generating stations do occur. That the individual generating units in central stations are far from giving 100 per cent service is indicated by the 1925 records of 191 large steam turbines, averaging nearly 30,000 kw. each. The turbines were in service 65.1 per cent of the total hours in the year, were idle but not needed 21.3 per cent, and were down for turbine, generator and condenser outages 13.6 per cent of the year. In other words, as an average, each turbine was needed in service 6,900 hours per year, but was down for repairs 119 hours, or 17.3 per cent of the time it was needed.

In hydro-electric plants outages of the generating stations result usually from water shortage, as occurred last

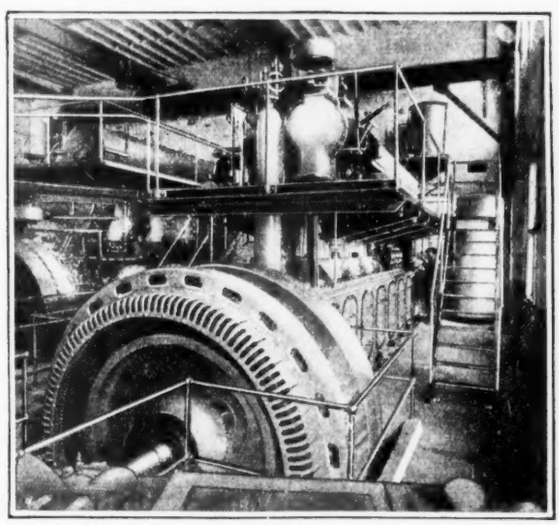


Fig. 2—600-hp. Diesel in a Kansas light plant where no excess equipment exists

year in Alabama and other Southern States, and made it necessary for a number of industrial establishments to run on part time, and even to shut down completely.

High-tension electric power carried over long transmission lines is exposed to many hazards. Interruptions are caused by lightning, wind, sleet, current surges and similar line troubles. The frequency and duration of

these outages vary widely. The line service records for the year 1925 of several electric utilities operating 17 transmission line systems in different parts of the country show 37 interruptions of service totaling 531 hours. On the average, there were on each line 20 outages per year, each outage lasting an average of 1 hour and 35 minutes, one outage lasting 12.5 minutes, while the worst record was on a line that suffered 78 interruptions, with an average duration of 2 hours and 19 minutes.

Interruptions in service due to troubles in local distribution to customers' meters vary greatly with circumstances. Overhead construction is comparatively light and therefore more susceptible to damage than the more strongly built long distance lines. On the other hand, when outages occur in local distribution, they are confined to a small locality so that usually only a few consumers are affected.

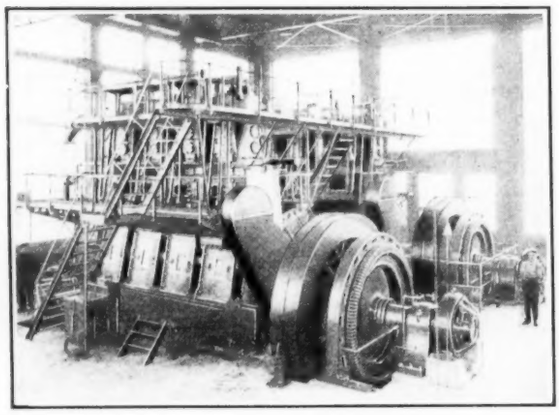


Fig. 3—A flour mill uses two 750-hp. Diesels without a reserve

Advantages of Private Plants

It seems evident, therefore, that in spite of all precautions, purchased electric power is not unfailing.

The private power plant is free from the hazards of long-distance transmission and local distribution. The reliability of its service, therefore, depends solely upon that of the machinery itself.

But how reliable is the oil engine? As the question is whether to install a spare unit in a new plant, we are interested in modern oil engines, not those of fifteen years ago. The period of pioneer development has now passed, and oil engines constructed by experienced manufacturers during the last five years are a superior product. The causes of cylinder head cracks and crankshaft breakages are now well understood and easily avoided. Thousands of operating engineers have become familiar with oil engines and have learned to avoid the mistakes of the past. Nevertheless, in spite of the early state of the art many old engines have given an excellent account of themselves. One oil engine, the sole power for a refrigerating plant, has been in service 21 years without one day's compulsory shutdown. A large oil pipe line which has been running 42 engines on continuous heavy load, 24 hours a day, 365 days a year, for 15 years, without any spare units, recently reported that the engines had been in duty 98 per cent of the total possible time.

The records of numerous modern oil-engine plants running under various conditions have uniformly testified to an exceedingly low percentage of time out for repairs. Table I shows a typical month's record of an oil pipe line installation comprising three pumping stations, each containing three pumps driven by modern oil engines. This equipment is required to operate under heavy load continuously; that is, 24 hours every day of the month. There are no spare units. The performance, 99.70 per cent, shows but little variation month after month.

Oil Engines Are Reliable

Another indication of the reliability of modern oil engines is given by the practice of many oil-engine-driven ice plants of running the engines continuously throughout the entire summer, minor inspections being made only when the equipment is shut down because the ice storage room is full, or for some other reason independent of the engines. In central station work still longer continuous runs have been made. In 1924 a non-stop run of 201 days was made in a Kansas municipal power plant, and last year in another municipal plant a different make of engine completed a non-stop run of exactly fifteen months, the shutdown even then having been quite voluntary.

Generally speaking, a local oil-engine power plant without any spare units is at least as reliable as purchased electric power. Therefore, when making comparisons between the cost of oil-engine power and the price of purchased current, the proposed oil-engine plant need not include a spare unit. The engines must of course be of adequate size for the load, but there is no reason for figuring on duplicate equipment unless a greater degree of reliability is wanted than may be reasonably expected from purchased power.

If more reliability than this is needed in a local power plant, it may be obtained in several ways. A spare engine of the same type as the primary equipment may be installed. A less expensive plan is to use one or more high-speed light-weight Diesel engines such as are now being put out. A still cheaper form of reserve power is the large gasoline engine often used for fire-pump work in municipal plants. Finally, a breakdown connection

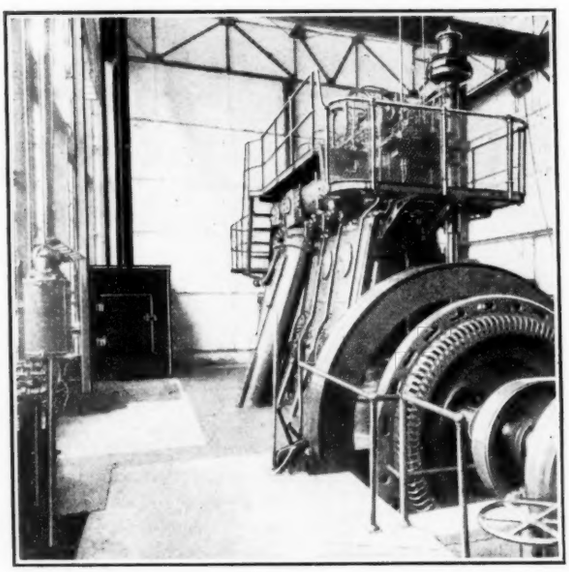


Fig. 4—Diesel is sole prime mover in a vegetable-oil mill

may be made to the public service lines. In any case, the cost of providing such an exceptional degree of reliability should be considered as insurance, and whether or not it will pay to provide it will depend upon the cost of the insurance compared with the possible loss from outages.

To get an idea of the cost of breakdown insurance, take, for example, a load of 100 kw. A spare Diesel engine and generator installed complete with accessories would cost about $15,000. If interest, amortization, insurance and taxes are taken at 10 per cent, the overhead charges on this spare equipment would be $125 per month. The operating expense when the spare unit was running would, of course, be the same as that of the regular unit and would therefore involve no extra cost.

The cost of a breakdown connection to the public service would depend upon the rate schedule in the particular locality. One schedule makes a minimum charge of $1 per hp. of demand, permitting its use for 13 hours without extra charge. For a 100-kw. installation equivalent to 133 hp. the monthly cost would be $133. During the time the electric power was purchased, the fuel and lubricating oil for the engine would be saved, but this would be a small item, about 65c. per hour.

Breakdown Connections

The cost of such insurance in a private Diesel plant for the purpose of obtaining a higher degree of reliability than that obtained with purchased power is usually considered too high in proportion to the risk. Therefore, the present-day tendency of experienced users of oil engines is to put in a plant of ample size for the load and to dispense with spare units or breakdown service.

[SERVICE RECORD OF 9 OIL-ENGINES DRIVING OIL PIPE LINE PUMPS

	Time Out for Repairs and Adjustments, Hours	Time In Service, Hours	Time in Service Divided By Time Wanted, Per Cent
Station A			
Unit No. 1	0.58	719.42	.....
Unit No. 2	9.08	710.92	.....
Unit No. 3	0.00	720.00	.....
Total	9.66	2,150.34	99.55
Station B			
Unit No. 1	4.68	715.32	.....
Unit No. 2	1.32	718.68	.....
Unit No. 3	0.93	719.07	.....
Total	6.93	2,153.07	99.68
Station C			
Unit No. 1	0.43	719.57	.....
Unit No. 2	2.47	717.53	.....
Unit No. 3	0.16	719.84	.....
Total	3.06	2,156.94	99.86
Grand total	19.65	6,460.35	99.70

Bulletin 164 of the Engineering Experiment Station of the University of Illinois contains the published results, so far obtained, of the "Investigation on the Fatigue Strength of Cast Iron," a piece of research work made possible through the financial support of the Allis-Chalmers Manufacturing Company, Milwaukee, Wis. The main purpose of the investigation was to collect data relative to the capacity of gray cast iron to resist repeated stress. The results reported in the Bulletin should be of material value to the designers and builders of machine and structural parts which are subjected to repeated stress.

When pure carbon monoxide gas is burned, only a pale-blue flame results, because true gases do not glow to any great extent when heated. Solids, on the other hand, always glow at high temperatures and appear dull red, bright red, yellow or white, according to temperature.

Answers to What Do You Know

The questions are on page 167

Ans. 1—The frequency of an alternating-current generator equals the number of poles times the speed in revolutions per minute, divided by 120.

Ans. 2—The expansion of the hot inner sheet and that of the colder outer sheet are not the same. If rigid stays are used, the bending stresses may break them.

Ans. 3—It will evaporate more pounds of steam at 10 lb. The heat to be added to a pound of water at 212 deg. to generate dry saturated steam at 150 lb. is 1,015 B.t.u., while a pound requires 980 B.t.u. to generate steam at 10-lb. gage. The total heat absorbed is the same in either case.

Ans. 4—Place the piston in a tub of lye water, and after the carbon is softened, scrape off with a brass strip.

Ans. 5—No advantage exists in case of a horizontal-tubular boiler, but with firebox boilers having little steam space the dome offers a steam storage space.

Ans. 6—The joint should be located over an arm, for the centrifugal force on the rim between the arms puts it in the condition of a beam fixed at the ends and uniformly loaded. The maximum bending movement occurs at the mid-position. If the joint is between arms, the inner edge of the bolt lug or flange acts as a fulcrum and the joint is opened by the outward pressure.

Ans. 7—A shaft may be considered as a beam supported at the ends and loaded at the center by the flywheel weight and belt pull. The maximum stress occurs at the center, which is made of large diameter to accommodate the higher stresses.

Ans. 8—No, the pull is not equal to one-half the weight but is more than this. The exact stress depends upon the length of the sling with a constant span.

Ans. 9—The 13.85 lb. atmospheric pressure is equivalent to a head of 28.19 in. of mercury, but this does not enter into the solution. The 24-in. vacuum indicates that the difference in pressure between the inside and outside of the tank is $24 \times 0.49 = 11.76$ lb. This is the net pressure tending to collapse the tank.

Ans. 10—By proper design the liquid at the exit can be cooled below the saturation temperature of the vapor; this is due to the fact that the distance between the outgoing liquid and the vapor space is considerable and the temperature of the vapor is equal to that of the portion of the liquid close to the line of demarcation.

Even with 100 Per Cent Excess Air the actual temperature produced in a boiler furnace is far above that needed to ignite the fuel mixture and the burning, when started, will keep up as long as gas and air are supplied. However, if the gases are allowed to enter a bank of water-cooled tubes before combustion is complete, the sudden cooling may reduce the temperature of the gas below the ignition point, with the result that combustion ceases from that point on, and any unburned carbon monoxide goes to waste. It is a fundamental principle of practical furnace design and operation that the gases should not come in contact with the boiler tubes or other relatively cold surfaces until combustion is complete. Otherwise there will be a loss due to incomplete combustion. As a rule the combustion is visible; that is to say, "flame" can be seen at all points where combustion is going on.

EDITORIALS

F. R. LOW, *Editor*

Over-Engined Ice Plants

IT IS not unusual to find ice plants using oil engines to have a ratio of four horsepower per ton of ice capacity. This is considerably greater than the duty demands and entails a high overhead that at times offsets the operating savings.

Apparently, the high ratio has been prompted by results in older plants where the engines were too small, and the engineering pendulum has swung to the other extreme. One may safely conclude that study will reveal a means of reducing the installed horsepower. The present plan of having a generating unit to handle the accessories, such as pumps, is undoubtedly of advantage, but the capacities usually installed are much too large for the work. During the winter months both the compressor engine and the generator engine must be kept in operation, although the load is light. It would seem that a better plan would be to have the generating unit drive a compressor of a size suitable for winter operation, with the second compressor of a size sufficient to carry the additional load during the summer. This plan would eliminate the necessity for a stand-by unit and so decrease the investment cost, while insuring continuity of service.

Corrosion

CORROSION is one of the principal deteriorating factors with which an operating engineer must contend. His steel structures rust away unless well protected by paint or encasing material. His boiler-feed piping, valves and the boilers themselves are subject to pitting and also to rusting. He may also experience trouble with the wasting away of his low-pressure turbine blades. Then condenser tubes under certain local conditions are subject to corrosive influences that induce early failure.

All these forms of corrosion are not due to the same causes. In fact they may be quite different. Much study has been devoted in recent years to corrosion, and the causes are gradually becoming more clearly understood. In general the modern tendency is to account for corrosion in its various forms by the electrochemical theory. Much of this theory is of recent development, and close study will be required of an engineer to secure a thorough grasp of these new ideas. On the other hand, a clear conception of the underlying causes will enable one to move with greater assurance in taking steps to prevent or offset corrosion.

How can corrosion be lessened? What effect does the process of manufacture, the composition of the metal and internal and external influences have on the rapidity of corrosion? Should copper-bearing steels be used where corrosion may occur? What preventive measures should be taken? Which paints are effective and which are not, in the prevention of rust under different conditions? How effective is deaëration and when is it warranted? What other measures of protection may be taken? These are all questions of the greatest interest to engineers, for which answers are eagerly sought.

Motor and Controller a Unit

PURCHASING a motor with little consideration other than that it is large enough to drive the load, does not generally result in a satisfactory power application. When a similar method is applied to the control equipment, the chances of obtaining a satisfactory power unit is made more remote. So far as possible the characteristics best suited to the load conditions should be designed into the motor. After this has been done, a control must be provided that will apply the motor characteristics and supply those that it is not possible to design in the motor.

A motor may be one hundred per cent satisfactory, but if the controller is not suitable the installation may be entirely unsatisfactory. Conversely, the controller may be of the right design, but if the motor is unsuited to the load conditions, the application may be a failure. If high starting torque is required, a motor must be selected that possesses this characteristic, as it cannot be provided by the controller. Likewise, where wide ranges of speed are needed, a motor must be selected that will operate satisfactorily under these conditions or, no matter how well the control is designed, it cannot supply the deficiencies of the motor.

It frequently occurs that a motor misapplied abuses the controller and causes high maintenance costs. Or the controller may impose such conditions on the motor as to cause frequent failures. Proper application is just as much a factor in obtaining low maintenance costs as the quality of the equipment or the workmanship put into its installation.

The amount of engineering required in motor and control applications will vary widely with conditions. If the

starter is a simple across-the-line contactor, the control problem is comparatively simple, consisting chiefly in obtaining equipment that will carry the motor current continuously without overheating, and rupture the maximum current successfully. The latter conditions are influenced to no small degree by the characteristics of the motor, consequently in this apparently simple application a knowledge of the motor's operation is necessary to choose the starting contactor intelligently.

When a motor is to be connected directly across-the-line at starting, it is essential to know that the machine and drive will stand the motor's starting torque. It is also necessary to know that the motor windings are braced for the mechanical forces produced by the starting currents. Even in this application it is evident that there are pitfalls that must be avoided if unsatisfactory operation is to be avoided. Motor and control applications, like almost any other equipment, are satisfactory to a degree depending upon the amount of intelligent engineering given to their selection. The motor is only part of the problem; the controller requires the same degree of consideration in its selection, and each should be chosen with due consideration for the other.

Is There a Shortage of Engineering Graduates?

INDUSTRY needs more and better-trained mechanical engineers. Prof. William T. Magruder, of the Ohio State University, recently stated that there was an average of three jobs offered every graduate of that school last spring. This is perhaps representative of conditions in general, and would seem to indicate that most employers believe the quality of training to be satisfactory. It is obviously impossible for a graduating student to be a highly trained specialist in the particular branch he may enter. No effort is made to accomplish that end. The aim of the technical school is to impart to the student a broad knowledge of the fundamentals of some branch of engineering and to help him to develop his mind in that type of analytical thinking required of an engineer. Upon these foundations, soundly laid down, he will be able to build the specialized knowledge pertaining to his job with reasonable experience.

It is true, however, that such an education is a good foundation not only for engineering, but likewise for business and executive positions. Many graduates do not follow strictly engineering careers, but rather take up work leading to managerial or executive positions in business or sales departments. Engineering concerns often prefer that their men in these positions have an engineering education. Many graduates are thus diverted from engineering, and this may account for the shortage to some extent. As to the cause, it is a fact that such work is more remunerative than straight engineering. When the student about to graduate in engineering sees the young bond salesman or real estate agent making substantially more money than he can hope to for some time to come, it is natural that he should waver. He may later realize that he has chosen unwisely, but the temptation was strong.

Adjustment of the difficulty will no doubt take place with the operation of the law of supply and demand. If there is a real shortage, felt by the industries, then the unsatisfied demand for the engineer should cause his value to increase. Conditions are hardly balanced when the men in charge of the business organization and the sale of a product are better paid than the engineers who design and produce that product. When students can look forward to jobs as remunerative as those in business for men of the same quality, a larger percentage of them will stay with engineering.

High-Strength Cast Iron

THE advantages of high-strength cast iron, especially for those parts where high strength and low weight are necessary qualities, are being given serious consideration by designers and builders of many types of power-plant equipment. The development of such an iron and the working out of a successful method of producing it efficiently and economically in the foundry will mean a radical change in our methods of design and construction.

At the present time much of our equipment, built principally of cast iron because of its low price and its ability to be cast into complicated shapes, is bulky and unnecessarily heavy. This is due to the fact that the strength of the iron is comparatively low. A high-strength cast iron, however, would permit the parts of such equipment to be made lighter and many times smaller, without a reduction in strength. In addition, the designer would be able, in many cases, to use iron castings where these are now out of the question because of the low strength. High-strength cast iron will enable the manufacturer to reduce bulk and weight, to increase strength and to reduce costs.

In connection with a consideration of high-strength cast irons it must be remembered that the United States is considerably behind foreign countries, especially Germany, in its program of research looking forward to the development of higher-quality materials. Germany, of course, is being forced to produce high-quality goods in order to cope with its foreign competition, consequently research is in the foreground. In the United States, however, research is not being given the same attention. We have, in the past depended upon our marvelous production capacity to meet competition. But in the future, if we are to meet and overcome competition, research must play a much more important part in our industries than it has in the past.

It is fortunate, however, that some companies and foundry associations in the United States are now at work on the problem of high-quality cast irons, the successful development and application of which will mean much to all machinery builders, but especially the manufacturers of power-plant equipment.

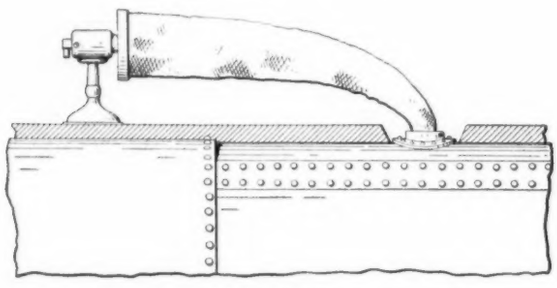
IDEAS *from* PRACTICAL MEN

Readers are urged to use this department for the exchange of practical operating information. A minimum of five dollars will be paid for contributions accepted

The Desk Fan in the Boiler House

Relining a boiler furnace only a few hours after the fires have been drawn, is pretty hot work at best, but the worker can be made quite comfortable by placing an ordinary desk fan in one of the firedoor openings of the furnace and directing the blast upon the workman inside the furnace.

The internal inspection of a steam boiler in less than six hours after the fires have been drawn is another hot



Keeping the boiler inspector cool

job which a 15-in. fan will make vastly more comfortable even when the candle melts in your hand and you "holler" for a bit of board to interpose between your knees and the hot boiler tubes.

It is not as easy to direct an air current from a fan into a manhole as it is into a furnace. I found that a fan did not run very well when placed down over a boiler manhole, so a sort of wind-bag was made, similar to the wind-posts in use on board ship. Light cotton duck was made into a tube four or five feet long, one end of which fitted snugly around the wire guard of the fan while the smaller free end of the bag was put into the manhole as shown in the illustration. Air pressure from the fan kept the air-pipe distended and made things comfortable inside the boiler. JAMES F. HOBART.

Indianapolis, Ind.

Balancing a Belted Generator

Lack of knowledge of the means provided for balancing a generator is sometimes the cause of easily avoidable difficulties in operating the machine. An interesting experience that occurred some years ago in a Nebraska town and will illustrate this point and may help someone having similar trouble.

Serious trouble was being experienced with vibration on a belted generator. I investigated the trouble and found that the machine was out of balance, vibrating so violently that the windows of the plant rattled and the covers over the bearing had to be tied down to keep them from jumping into the machine. The cement floor had even been cracked by the excessive vibration. In the investigation it was noticed that the generator had recently been painted and striped, although at the time this appeared to be an insignificant item. After viewing the trouble, temporary weights were obtained and placed in the field until the machine was balanced and running in perfect order.

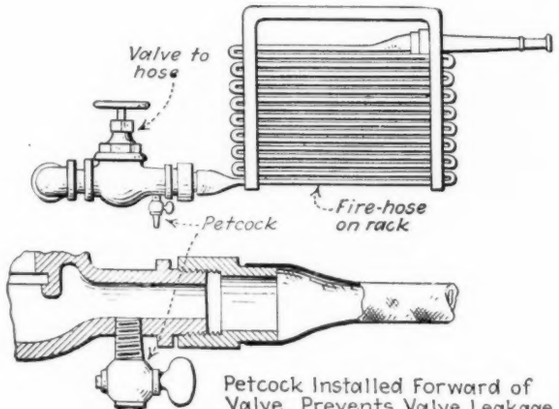
In discussing the matter with the chief engineer, I told him that it was necessary to bolt the weights in the spider. He thereupon expressed surprise and said that when the machine was painted the weights had been taken off, and not knowing the importance of them, he had intentionally left them out, filling up the bolt holes with cement. The original weights were placed on the generator and there was no further trouble from vibration. GEORGE F. MILLER,

Chicago, Ill. Westinghouse Elec. & Mfg. Co.

Protecting Fire Hose from Rot

In the power plant of a large Eastern manufacturing company considerable loss from rotting fire hose, caused the plant superintendent to adopt the method of protecting them shown in the illustration. This consisted in drilling and tapping the valve body just forward of the valve seat, for a small pet-cock.

The valve leakage, instead of penetrating the fabric hose and causing rot and mildew, is drained off at the



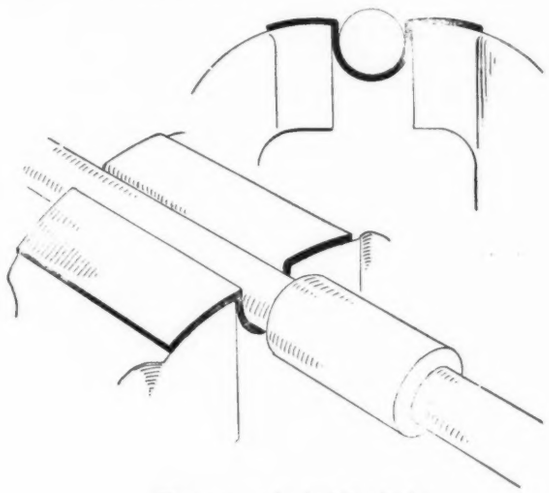
Pet-cock on fire-hose valve

pet-cock, which is left open. This pet-cock also serves to indicate excess leakage, at which time the valve is tightened further or repairs are made if considered necessary. GEORGE A. LUERS.

Washington, D. C.

Vise Jaws for Holding Heavy Shafts

The sketch demonstrates a simple and easy way to hold heavy shafts in a bench vise for filing, fitting keys, etc. It enables the engineer to handle a large shaft in or out of the vise and make any change of position without assistance. This device consists of a piece of copper or brass the width of the vise jaw. It is bent to conform



Copper strip holds shaft

to the circumference of the shaft, and the ends are bent back over the jaws. The shaft rests in the channel of the copper jaw, and the vise may be loosened up without danger of the shaft falling. H. L. WHEELER.

Syracuse, N. Y.

Wet Steam Causes Trouble with Oil Burners

While I was visiting a new plant a few days ago, the engineer in charge complained of having difficulty with the oil burners, which were of the inside-mixturing steam-atomized type and placed entirely outside the furnace; that is, the tip of the nozzle was approximately 2 in. from the outside of the boiler front, and sprayed the fuel into the furnace through a round hole in the brickwork—apparently with the idea of promoting a good air and fuel mixture. When starting up the plant in the mornings, it was necessary for a fireman to stand with a lighted torch in hand ready to relight the burners, as they would be extinguished many times before the furnace got warmed up, and even after the firebox was fairly hot, the fire went out frequently, causing considerable annoyance and waste of fuel.

Upon investigation it was found that the fuel oil was of good quality and contained no water; the fuel pump and oil supply system were in good order and apparently working normally. Watching the burner nozzles, it was noted that two fires were not always extinguished at the same time, also, that the spray leaving the nozzle seemed to turn much lighter in color as the fire went out. This led to the idea that slugs of water or wet steam were coming over and causing the trouble.

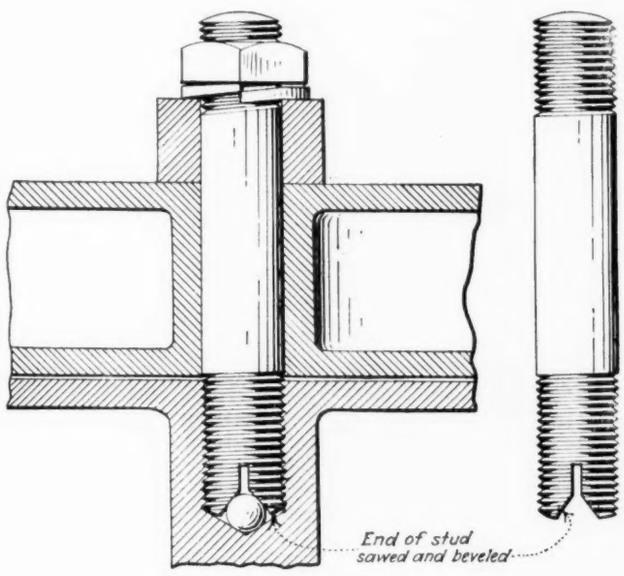
Opening a bleeder at the end of the atomizer line and permitting a considerable flow of steam to pass, would practically eliminate the trouble. A bucket trap had been installed at a low place in the line and was operating properly, but owing to its position being such that the velocity of the steam had a tendency to sweep the entrained water past its inlet rather than into it, it was believed that only a part of the moisture found its way to the trap. Tracing the source of the water, it was noticed that the atomizer line was taken off the steam riser directly above the main boiler stop valve. This being the first and lowest point at which any steam was taken off the system, any entrained water drawn from the boiler would thus find its way to the burners. It was admitted that less trouble was experienced when the water was near the bottom of the glass; also, it is reasonable to believe that considerable foaming and priming was taking place in the boilers, owing to the fact that much of the feed water was made up of condensate from an entirely new pipe and heating system which had not been thoroughly cleaned of the thread-cutting oil and pipe dope used during its construction.

Recommendations were made that either a separator be installed in the line to the burners, or the line be changed so that the steam would be taken off the top of the header through a vertical riser, which should extend several feet above the header and then loop directly over and down to a point as close to the burners as possible. A. C. MCHUGH.

Norwalk, Calif.

Tightening Studs with a Steel Ball

When stud bolts work loose, especially those holding gaskets, it is not practicable to employ any of the usual methods of locking them. It may be possible to fit a new and larger stud if facilities are at hand to do this



Holding a loose stud with a ball

machine work, but in the absence of machine equipment one of the best and most convenient forms of locks is the use of a steel ball in the split end of the stud, as shown in the illustration.

This consists in sawing and cutting the end of the bolt with a hacksaw, so that it can be expanded. A small steel ball is then dropped into the stud hole, and the stud is screwed home. The ball expands the end of the stud, causing a wedging effect on the stud. This method is of use on any stud bolt where the thread is bottomed, and makes a reliable repair.

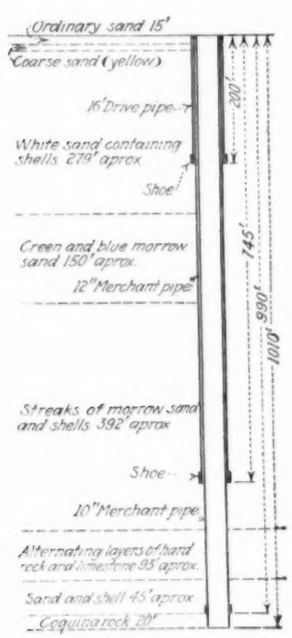
Washington, D. C. GEORGE A. LUERS.

COMMENTS *from* READERS

Maintenance of Artesian Wells

The article by Joseph O'Brien, appearing on page 713 of the May 10 issue, entitled "Pointers on the Operation and Maintenance of Artesian Wells," is interesting and contains a great deal of valuable information concerning the particular type or kind of wells described.

In certain sections of the United States it has been possible to secure flowing wells and in many instances such wells have sufficient natural pressure to cause the water to flow through the condensers or to other parts of the plant without pumping.



Method of drilling an artesian well

During the several years in which I have had an opportunity of observing many such wells, I have noted that in a great many instances natural flow artesian wells have given trouble shortly after being put into service. Beginning within a few months, or even a few weeks after the well was completed the yield has gradually decreased until it has become necessary to use a pump to increase the yield.

An investigation of many such artesian wells to determine the cause of reduction in flow has shown that almost invariably the fault could be laid at the door of the well driller. Sometimes, however, he is not so much to blame as the owner, since the latter often refuses to spend enough money to get the right kind of a job and the well driller, not being able to convince the owner that he should follow the best practices, has let himself in for a lot of trouble.

In the localities to which I particularly refer, the wells yielding large volumes of water usually terminate in rock, and before the water-bearing rock is reached it is necessary to go through large deposits of sand and other loose soil strata. Unless care is taken to continue the pipe on down through the sand into the rock strata, it is only a question of time until the well begins to cave in above the water-bearing rock, which means of course that the natural flow is greatly diminished and in some instances almost entirely shut off.

In the illustration is shown a drawing of an artesian well which has a total depth of 1,010 ft. and in which the water supply comes from a formation of coquina rock, as noted at the bottom of the drawing. The well driller, in starting this well, took every precaution to get as much information as possible concerning the character of the soil with which he would likely have to contend. To be sure of getting a full 10-in. diameter pipe to the water-bearing rock, he began the drilling operations by using a 16-in. pipe fitted with a shoe at one end, as shown. After drilling and driving this pipe a distance of 200 ft., the sand packed so tightly around the external walls of the pipe that it was not possible to go any farther.

On the inside of this pipe the well driller next used a 12-in. pipe which followed the drill to a total depth of 745 ft.; at this depth the sand had packed so tightly that it was impossible to drive the pipe any farther. He next set in a 10-in. pipe, which he was able to drive to the water-bearing strata. The drill used was one that made an opening slightly larger than the external diameter of the pipe, and after the rock was reached, the hole was drilled some 20 ft. and the pipe seated on the rock at a depth of 990 ft. below the surface. The 10-in. pipe, which was fitted on the lower end with a shoe, was driven down hard into the rock so as to make a water-tight joint between the drive shoe and rock. The total depth of the well, including the drilling below the end of the pipe, was 1,010 ft. At this depth the maximum flow of water was struck, which, upon being measured, was found to be a little better than 1,500 gal. per min., and the pressure at the top of the well when the valve at the top was closed, was found to be 18 lb. per sq.in.

No trouble has been experienced with this installation, for the plan followed of casing out the sand lying above the water-bearing rock prevented any loose material from finding its way into the finished well. C. T. BAKER.

Atlanta, Ga.

Fallacy of Measuring Boiler Output by Feed-Water Input

Probably there are few engineers today who do not realize the necessity of checking the steam output of their boilers. This practice is, of course, a primary step in the determination of operating efficiency and costs. There are, however, probably quite a few plant operators who believe that it is sufficient to measure the feed-water input rather than the steam output.

The fallacy of this reasoning lies in the fact that plant ownership is not interested in the amount of water evaporated, since this necessarily includes blowdown losses, plus steam waste through the safety valve. The plant owners want to know how much steam is generated and delivered to a point where it does useful work.

The chief value of measuring water input to the boilers is the possibility of measuring boiler losses by comparing the amount of water supplied to the amount of steam generated. In the absence of a means of measuring steam output some engineers bolster up their assumption that measurement of water input is sufficient by the practice of running boiler and furnace tests from time to time. Such tests are, of course, valuable, but it must be borne in mind that in most cases they are operated

under conditions as nearly ideal as circumstances will permit. Results are, therefore, correspondingly idealized rather than presenting a fair picture of average operation.

Proper means of continuous measurement of steam output provides what amounts to a continuous test, reflecting actual conditions. Moreover, in many instances the cost of running a special test would equal or exceed that of providing adequate equipment for continuous measurement of steam output. This latter consideration is a wholesome corrective to the thinking of some engineers who confuse efficiency with economy. It must be remembered that dollars and cents are the standard by which power-plant operation is judged. A plant improvement may effect better efficiency, but it will prove profitable only if it produces an operating economy sufficient to pay off the cost of the improvement within a reasonably short time.

From this point of view the steam-flow meter is one of the most profitable of power-plant instruments. It can easily be shown that a moderate improvement in load distribution, such as might be expected by the introduction of steam-flow meters in the average boiler room, produces sufficient betterment in boiler operating economy to pay for the flow-meter installation twice over in a single year. And this is but one instance.

Taking all of the economies resulting from the use of steam-flow meters, it has been claimed that a certain boiler-meter installation has, since it was first put in operation, paid for itself every 18 days, this conclusion having been drawn from operating records.

By a calculation based on typical operating conditions, it has been determined that a representative flow-meter installation costing about 17 cents a day will effect a saving amounting to $17 a day; in other words, the flow-meter equipment pays for itself 100 times during its life.

F. V. WETHERILL,
Engineering Dept., Brown Instrument Co.
Philadelphia, Pa.

Temporary Jobs Increased Salary

I read with great interest the article in *Power* entitled "A Temporary Engineering Job," by H. M. Friend, because it exactly covers my own experience during the last sixteen months.

Like many other ex-service men, I found it difficult to readjust myself to civilian life following my discharge from the army in 1919. When I seemed to be on my feet again and making good progress, I was laid off during the slump in January, 1920, for, being one of the last men hired, I was among the first to go when the working crew was reduced.

After being unemployed for two months, I was hired as a general-utility man in one of the Pacific Coast public-utility power plants at $5 a day. I had held higher positions, but under the circumstances I decided to accept this and endeavor to work up from it as a beginning.

I held this job for ten months and was then advanced to second operator at $135 per month, which latter rating I held for two years. During this time I repeatedly tried to secure a better rating, my object being the engineering department. However, as I had higher qualifications than the ordinary run of power-plant hands, the chief and the operating superintendent were well satisfied to let me remain where I was. As to the personnel manager, I soon discovered that he was the official goat for all departments, and nothing could be secured from him.

During the same period I tried to obtain work in the engineering departments of other firms, but I found that being an operator was a barrier to obtaining other work, as most employers considered a period of operating unfitted a man for anything else. For a beginner they preferred a younger man at less pay. Another barrier I found to be the large number of foreign engineers and draftsmen. Many of these men had had high technical training and years of experience in Europe. They would come to the Pacific Coast ports in the engine rooms of foreign vessels. On arrival they would leave their ships and seek shore positions. As most of them were unable to speak English, they would take anything obtainable to start with. Many employers took advantage of their handicap to secure their services at low pay. One public utility drafting room force consisted of 160 men of 19 nationalities, including the white, black and yellow races.

After two years as second operator, I went to headquarters and asked for a change. I was then transferred to the drafting room as a detailer at $150 a month. The chief draftsman told me that I was in his department on trial, and that if I made good I could expect a raise when I earned it, but otherwise I would be unceremoniously turned out without the alternative of going back to operating.

In the drafting room I discovered that the method of keeping wages low was to hire each man individually for the lowest pay he would accept and then break him in to do one thing and leave him there permanently or until he got disgusted and left. I held this rating for two years, but I know now that all I learned over the drafting board I learned in the first six months. It was almost impossible to learn anything about the work beyond the particular part I actually worked on.

The company had some educational courses for their employees, but they were very elementary. As I had a college education, they were of no use to me. I tried to improve myself by reading and by visiting as many of the plants as I could on my own time.

After two years in the drafting room I decided it was time to make another try for advancement. The personnel manager was selected to do the dirty work. I was sent to him for an interview, and he informed me that as all departments were reducing their payrolls, a transfer or promotion would be impossible and that as the cut included the drafting room, I might be one of the men selected to be laid off. An hour later the assistant chief draftsman came over to my table and told me that as a cut was coming, it might be to my interest to look elsewhere, particularly if I thought I was worth more than my present pay. While not his exact words, his meaning was to the effect that as I had been there long enough to pay back more than the cost of my training, they would prefer to have me leave and be replaced by another man rather than raise my pay or promote me to a better grade of work. On the other hand, if my services were as valuable as I considered them to be, I had better find another employer who would accept my valuation.

I might have gone to headquarters and demanded a show-down, but I decided that it would be to my interest to stand on my own feet and find other work instead. When the list of men to be laid off was announced, it was noticed that most of them had been with the company for some time, some as high as six years, while some of the men retained had been with the company only a few weeks. Another noticeable feature was that, as the men had over a month's notice, nearly all had positions at higher pay long before the month was up.

Here is where the temporary jobs worked to my advantage: Shortly after receiving my notice of the impending lay-off, I learned of a draftsman's position with a tractor company. Between being only a temporary job and being at Stockton, a disagreeable place to live in during the hot summer months, the place had been open for three weeks. I offered to accept the position immediately, provided they would pay $200 a month or $50 more than I had been receiving, which was agreed to.

After the reorganization of the tractor company, the Stockton plant was turned over to a harvester concern, a subsidiary devoted entirely to the manufacture of agricultural machinery. The drafting-room crew consisted of only four men. I soon found that while my pay was higher, my new employer actually secured my services for less. First, there was no loafing or visiting in the drafting room, and work hours were strictly observed. Then I was hired as a high-grade man and was expected to return proportionate results. I had to stand on my own feet. My work was no longer laid out for me and passed on by someone else. Instead, I dealt directly with the shops. I had to handle all my jobs from start to finish unaided, and frequently without the chief's even looking at them. I not only had drafting to do, but had to handle some of the shop routine as well. Furthermore, I had to plan my work to reduce manufacturing cost wherever possible. As a consequence I made much more progress in the six months at Stockton than I would have done in several years in the power company's drafting room.

Knowing this job to be temporary, I kept expenses down to the minimum and had a nice little getaway stake to show for it. I was promised three months' work, but between heavy orders and the developing of two new models, the work actually lasted six months.

When the work terminated at Stockton, I was tired out as a result of the heat and the high-pressure work. So I took a vacation trip to Southern California. One day I read in the paper that the Los Angeles Steamship Co. had bought a steamer and had sent it to a shipyard at San Pedro to be remodeled. This sounded like work for somebody, so I applied at the shipyard and was employed as an engine draftsman. I was promised four months' work, but it actually lasted twice that time. The scale of wages in southern California is lower than in the north, but as I was hired temporarily, I was paid $200 a month with time and one-half for overtime.

Once again it was a case of a small crew of draftsmen, and I had to be able to handle any job that came along. As a result I gained a wide variety of experience on boiler and engine room drafting, for no two jobs were alike. The men had followed a wide range of work all over the world, so I learned not only by my own efforts but also through help from them.

Just as the shipyard job ended, a position opened up in the mechanical engineering department of a utility company in southern California which promised to be steady and lead to advancement. As a result of my experience on my two temporary jobs I was able to secure a much better position at higher pay than if I had stayed on with the original utility company. Furthermore, the southern California company is reaping the benefits of my training with the San Francisco utility at the expense of and at a loss to the latter company.

As a result of my experience I can truthfully testify that a temporary job may bring results in a few months that would require years in a permanent position.

Los Angeles, Calif. HOWARD LIVINGSTON.

Where Plant Savings Are Possible

The editorial appearing in the June 28 issue, entitled "Savings Possible to Power Plants," is certainly timely.

The cotton industry alone offers a fertile field for the application of ideas along the lines outlined in the editorial, and if a number of mills would take the trouble to total up their fuel costs and the cost of purchased power, they would be surprised at the results.

When one observes many plants operating several boilers for the purpose of supplying steam heat in the winter and for continuous process work the year around, and purchasing large blocks of power in addition, it is evident that something is radically wrong somewhere.

It would seem, in view of the great mass of data that has been published from time to time, that those responsible for the laying out of plants which are equipped with large boiler installations and which furnish steam from heating and process work, from which no power whatsoever is derived should give some thought to the economics of the situation.

The editorial in the same issue, entitled "Is Stand-by Equipment Justified?" brings to light the fact that many industrial power plants have gone to extremes in the matter of stand-by equipment, with the result that their investment costs are abnormally high, which in turn is reflected in high overhead costs per unit of power output.

There is such a thing as paying too much for insurance, and when this is done the cost of insuring against interruption of service becomes a burden in the form of interest and depreciation charges which, in the final analysis, is not justified.

The writer recently observed a report that had been made to show the cost of developing power on the premises of a certain factory and the cost of purchased power. It was noted that those responsible for the report had, in figuring the costs of generated power from the isolated plant, based their cost on duplicate equipment throughout, including duplicate engines and generators, switchboards and boilers. This called for practically twice the investment that was necessary and made the generated power costs high.

As a matter of fact, the plant in question was operated not to exceed ten hours a day, six days in the week, which would allow ample time for necessary repairs and boiler cleaning.

The owners finally decided that it was unnecessary to resort to such large capital expenditures for the sake of insurance. This resulted in the purchase of one boiler with necessary feed-water heater and feed-water pumps and one engine-generator set of high efficiency. Since the installation has been made, there has not been the slightest interruption to service and ample time is available for all necessary boiler cleaning and general repairs.

In too many instances the idea of duplicate equipment throughout has amounted to an obsession on the part of some engineers, and they have, by following this obsession, penalized the power plant by unnecessarily high overhead expense.

Is not the quality of the materials used and the workmanship and the ability of those in charge of plants as good or better today than twenty-five years ago? Is it not true that many of us have been seeing ghosts when we insisted on spending an additional 100 per cent of the economic first cost of the plant for the mere sake of insurance against breakdowns? How can one justify such illogical and extreme practices? C. T. BAKER.

Atlanta, Ga.

Where Stands German Industry?

By Edward J. Mehren

Vice-President, McGraw-Hill Publishing Company, Inc.

"WHAT is happening in Germany?" has been a leading question with Americans ever since the war. During the inflation period we were disturbed at the low-priced goods she shipped to us. Her competition is still felt in some of our home markets, while reports of her activities in industrial consolidation and cartels prompts frequent repetition of the question.

An exact, but brief, answer is not easy to give. The evidence in some matters is conflicting, indicating that there is still unsettlement. Nevertheless, the general situation can be stated briefly, and answers hazarded to those obvious collateral questions, Whither is the Reich going? How far will it go?

The Background

To begin with, let us build a background. Here is a nation that had grown to industrial greatness in a generation. She had become one of the leaders in international trade. Everywhere was the German commercial flag.

Then she was pushed from her high estate. Through the Versailles Treaty she lost 13 per cent of her area, 10 per cent of her population, 20 per cent of her coal mines, 74½ per cent of her iron ore, and 68.3 per cent of her zinc ore. Her colonies were seized, her merchant shipping wiped out, her foreign investments largely confiscated.

But that was not all. Inspired by the new nationalization growing out of the war, and crystallized by the application of the theory of "self-determination of small nations," custom barriers sprang up all over Europe and cut off markets. Russia practically disappeared as a buyer. The British colonies adopted Empire preference policies.

Meanwhile, unrest had torn the country. Class was set sharply against class and social legislation, far-reaching in type and cost, was enacted. Finally, the mark took a long slide to nothingness, completing the wreckage of the economic structure. In 1920 the political rebuilding of the Reich was started; in 1923, through the stabilization of the mark, the economic.

Now, after four years where stands the Reich? Whither is it going? How far will it go?

Progress Rapid

First, let it be said, that the progress has been astonishing. I was in Germany in 1920, when everything was at a low ebb. I was there in 1924, eight months after the mark had been stabilized, when hope had again been kindled, but when only the beginnings of progress were visible.

What a contrast now! The industries are effectively organized, the workers are fairly well satisfied and are working diligently, the general spirit of unrest and discontent has disappeared — although some claim that this is only on the surface—and, above all, there is a drive and a spirit of sacrifice and devotion among the leaders and managers of industry and trade that is inspiring. They do not know how long it will take to reach a truly stable economy, with the workers on a satisfactory standard of living and with industry on a reasonable net earning basis. But the immediate tasks are clear and to their solution the leaders of German commerce, industry and engineering are applying tremendous energy, intelligence and patience. They are working hard and thinking hard.

THE author recently returned from a four months' visit to Continental Europe during which he attended the Economic Conference in Geneva, the International Chamber of Commerce Convention in Stockholm and spent considerable time in Germany gathering first-hand information on industrial conditions. Aside from their general interest, his observations should be helpful to manufacturers either engaged in an export trade or in competition with products made in Germany. In a second article Mr. Mehren will discuss Germany's industrial future—Editor.

Business Conditions

Just now business is active, but it is feared by some that the present demand for goods will not keep up. The stimulated production is for German use and not for export.

The present improved situation is due largely to the British coal strike and to some extent to the Russian orders taken last year. The British strike created a demand for German coal, and its production, in consequence, ran above that of 1913, excluding the lost areas. The mines, in turn, bought new equipment, headworks, etc., thus stimulating the steel trade. The machinery industry even today remains active, although new inquiries are dropping off. Had the steel production been for export, the situation would be brighter. The situation has been helped, too, by orders for ship steel, the builders desiring to take advantage of the subsidy which applies only to ships built this year. The Russian orders helped, but were of much less importance than was the strike stimulus.

While, therefore, the condition just now is favorable relative to the situation late in 1925 and early in 1926, the economic condition is still abnormal and must remain so for many a year.

Lack of Capital and Taxation

The overshadowing adverse conditions are lack of capital and burdensome taxation. The meager supply of capital comes up in every conversation with bankers, merchants and industrialists. It hampers chiefly in inability to finance foreign trade. A second handicap imposed by lack of capital is the inability to make plant improvements that will help reduce production cost. The increase of the supply in capital will be slow, except for foreign borrowing—which, obviously, has disadvantages. Taxes are too high to permit of rapid capital accumulation by industry itself and by the public. However, a beginning has been made in building up capital.

The second major industrial handicap is taxation, and this works in two ways—first, by taking large percentages of net profit from the industries themselves and, second, by taking so much from the individual that he has little to invest in industrial securities either directly or through savings and insurance deposits. Nevertheless, the investment fund is growing slowly as indicated by savings banks deposits already referred to and by recent successful flotation of loans in Germany.

In total the taxes on moderate-sized and large companies run from 40 to 50 per cent of the annual net income—when there is net income. Taxation of individuals is also heavy and varied. Income taxes start at 10 per cent on incomes over 1,200 marks. All over 8,000 marks pays 12½ per cent; above 12,000 marks, 15 per cent, rising to 45 per cent in the highest bracket.

Reparations Taxes

When people talk of their tax burdens here in Germany, it is common for them to place special stress on the reparations payments made under the Dawes Plan. They regard these payments as the principal cause of the high taxation; my questioning of people in different walks of life from laborers to industrial managers showed this to be true. As a matter of fact the Dawes payments for the year ending Aug. 31, 1927, certainly are less than 12½ per cent of the total taxation of Germany, including the taxation of the Reich, the states and the communes.

The rise in taxation is due largely to the war burdens of pensions, to payments to those who suffered damages

or injuries in the war, to sickness insurance benefits, to special appropriations for the help of the unemployed, for state aid for housing and for other purposes believed unavoidable and outside the range of ordinary government expenditures.

Social Burdens

But there are still other burdens and handicaps. There is, for example, what is generally called here the social burdens. These consist of the payments which industry must make to special funds, such as those for sickness insurance, unemployment and invalid and old age pensions. These payments are in addition to the requirements of the budget for extraordinary assistance to unemployment and sickness insurance funds. The extent of these burdens can be shown by a few examples.

Tariff Walls

Obviously, Germany with her large population and her highly developed industrialism cannot consume at home all she can manufacture. But in foreign trade she strikes everywhere high tariff walls. This barrier is all the more serious, because Germany has a large foreign debt—reparations and loans, the latter chiefly from America—which she can pay only by having an export balance. The unfavorable balance had been decreasing during recent years. In fact, by making a special selection of an annual period, namely, the year closing Oct. 31, 1926, an export balance of 176 millions is found. Recently the adverse balance has sharply risen, due to rapid increase in importation of raw materials caused by the internal trade boom. In the first four months of this year the adverse balance was 1,174 million marks. Obviously, an export balance can be created by working in two directions, by decreasing imports and increasing exports. To work in both directions is the general policy of Germany's banking, commercial and industrial interests. Some of the steps being taken in these directions are noted later in this article.

Favorable Factors

As a result of the conditions recited, the whole complexion of business in Germany is such as to discourage the stoutest hearts. Many companies have, indeed, had to pass their dividends recently. Yet in the situation are favorable factors. One of these is the curtailment of speculation through the action two months ago of the Reichsbank, when it discouraged loans for stock exchange purposes. This should result in the diversion of money into investment channels. Another favorable factor is the courageous attitude, broad vision and hard work of the leaders.

Still another favorable factor is a labor cost relatively low compared with that of other countries, but coupled here with diligence and high intelligence. The skilled workers get from 0.85 to 1 mark per hour, depending upon the industry and district.

Incidentally, index figures, taking 1913 as a basis, show that wages have risen 160 per cent and the cost of living, 146 per cent. But the figures do not seem to agree with the facts. Testimony is universal among the workers—and I have spoken to dozens of them—that they are not as well off now as before the war.

Employers testify that the works' councils established by law in every factory, have, in general, ceased to be radical and political and are a help rather than a hindrance.

Finally, it should be considered remarkable that the working people, with their standard of living reduced and a revolution, with conditions nearly chaotic, only nine years behind, have settled down so well. Indeed, the judgment seems sound that one of Germany's greatest assets is her steady, industrious intelligent workers.

(*A second article will appear in an early issue.*)

Developments in Ventilating Electrical Machinery*

VENTILATION of electrical machinery is an important consideration not only with regard to the cooling of the machine itself and the supply of an adequate amount of clean, cool air, but also as a means of deadening noises inherent in the operation of large and high-speed machines. In the endeavor to realize every possible economy for obtaining high efficiencies, attention is being paid to relatively small features of construction to obtain small resistances to the passage of cooling air, and much attention has been paid to forms of fans. The importance of giving consideration to small details in improving efficiencies of turbine-driven alternators has led to investigations in the laboratory by the use of a model in which changes in fingers, slot wedges and dimensions of slots can be readily made and the effects determined. These are also being made to study the flow of air through rotors.

Closed ventilation systems have been adopted for hydro-electric plants. The question may well be asked, What consideration would make it advisable or desirable to use a closed system in a water-power plant? Many water power plants are situated remote from sources of smoke and dust. Conditions that make it advisable to provide a closed system often surround power houses.

Hydro-electric plants on rivers in the midst of manufacturing plants where much coal is burned have as much need of this type of ventilation as the turbine-driven generators in steam plants in the same locality. There are also conditions in some remote locations which make closed systems advisable, such as severe dust storms in barren districts. It often happens that the initial installation in a hydro-electric development is only a small part of the final capacity. There may be construction work going on over a long period after the first few units have been put into operation, with considerable dust from masonry work in the air. In an instance of this kind it was found that the generators had become sufficiently clogged with dust to raise their temperature 10 deg. F.

Another unusual application of the closed system of ventilation is in connection with a German Diesel-engine-driven 13,000-kva. 94 r.p.m. alternator.

Valuable data for future design work regarding hydrogen cooling have been obtained from thorough tests on a 6,250-kva. 3,600-r.p.m. 13,200-volt turbine-generator. These tests were highly gratifying and indicated that practically the same benefits may be obtained as may be expected from theoretical considerations. There are indications that hydrogen cooling may eventually be used for large synchronous condensers and frequency converters. It has been suggested that helium could be used for large synchronous con- hydrogen, and this possibility is being investigated. A seal has been developed to prevent the loss of hydrogen or the admission of air at the section where the shaft of the machine enters the end bell. Tests made over long periods of time on this type of seal have proved satisfactory. Tests have also been made on heat flow across laminations when surrounded by hydrogen.

During the last year extensive experimental tests have been made to determine the surface head transfer in electrical machinery with air flowing at various velocities through radial and axial ducts. Investigations have been made to determine the influence of shape, size, cross-section, conditions of the surface, mean temperature and several other factors.

The most important fact brought out in these tests is that the rate of heat transfer is not constant along the path of air flow, but varies in value from point to point along the path. This variation in the rate of heat liberation for a constant air velocity in a given duct is caused by the change in the turbulency of the air flow along the duct. As a result of this change of turbulency it is found that the rate of heat transfer near the entrance of a duct is about twice that at a point farther along, where stable flow conditions are found. This explains why electrical machines with short duct length have a capacity in proportion to their surface greater than those with similar ducts but with longer air-flow paths. This also explains why the surface heat transfer coefficient of a duct, averaged over its total length, will be an inverse function of the length. It also explains why results as given by experiments on machines with ducts of various length should not be uniform.

*Abstract from the American Institute of Electrical Engineers report of the committee on electrical machinery, presented at the summer convention, Detroit, Mich., June 20-24, 1927.

Modern Steam Turbine Foundations*

By Von Oberingenieur Dohme

IN ORDER to meet the demands of the static stresses in a turbine foundation, the magnitude, direction and behavior of the various forces that act upon the foundation and are a result of the weight and the operation of the machine must be known. As far as the dead loads are concerned, this part of the problem does not present any particular difficulty, since these data can be read directly from the load diagram of the manufacturer.

On the other hand, the determination of the dynamic stresses on the foundation, due to the operation of the machine, is more difficult. The main factor among these is the centrifugal force which, in contrast to the dead machine loads, attacks the foundation as an impulse due to its steadily changing direction. As is known, these forces, which manifest themselves as impulses, cause higher stresses in the foundation body than do the static loads. In addition, the building materials are less likely to stand up against such dynamic forces than against the effects of dead loads. Therefore, in the calculations the dynamic forces are usually multiplied by a factor of safety.

The first problem to be considered is the maximum centrifugal force. Then, the dynamic factor—that is to say, the value by which the maximum centrifugal force should be multiplied—must be determined.

An idea of the centrifugal force may be obtained when it is considered that the guide wheels inclose the shaft with packing rings, leaving a clearance of only approximately 0.004 in., which represents the degree of displacement possible with respect to the central axis. The displacement can increase beyond this only when the fine packing rings wear down. It can be stated as a limiting case, however, that when the shaft deflection has reached approximately 0.020 in., the friction is so great that the shaft runs hot and the machine must be shut down.

Considering the maximum deflection of the central axis, the centrifugal force can be calculated when the mass and the angular velocity of the revolving body are known. If the total weight of the machine (the total of the forces indicated in the load diagram) is represented by G, the rotating masses will be approximately 8 to 15 per cent of G. When choosing a high number of revolutions, say 3,000 r.p.m. or 50 revolutions per second, the centrifugal force F will be 0.75 G. In view of the fact that this force appears only in extreme cases and is only of transient nature, the centrifugal force F can be rounded off to approximately $\frac{1}{2}$ G.

As known, the magnitude of the centrifugal force depends upon the maximum deflection of the running shaft. This deflection has a certain ratio to that of the non-revolving shaft. According to data from the manufacturer, the deflection of the revolving shaft will be from two to five times the deflection of the non-rotating shaft. If the deflection of the non-rotating shaft is designated by f and that of the rotating shaft by $x.f$ then

$$\frac{f}{x.f} = \frac{G}{F}$$

Consequently the centrifugal force,

$$F = \frac{x.f.G}{f}$$

As already stated in connection with the static investigation of the foundation, the value of the centrifugal force obtained in this manner should be multiplied by the Dynamic Factor.

The Dynamic Factor, according to Doctor Rausch, in his "Dampfturbinengrundurger," is a function of the ratio between the natural frequency of the foundation and the number of revolutions per minute of the turbine.

If this ratio is called k, the natural frequency of the foundation n_e and the number of the revolutions of the machine, n_m, then:

$$k = \frac{n_e}{r}$$

and the Dynamic Factor, d, will be:

$$d = \frac{k^2}{k^2 - 1}$$

The magnitude of the centrifugal force to be considered in the static investigations consequently is $d.F$. In most cases the maximum value will come out as $d.F. = G$ approx.

In accordance with these formulas the value of the Dynamic Factor will be lower the higher the natural frequency in relation to the machine speed, consequently it is desirable that the natural frequency be as high as possible.

The centrifugal force acting at the same level as the shaft of the machine affects the foundations in the most harmful manner, first, at the moment when its direction is horizontal, and, secondly, when it works vertically downward. All other directions of the force can be ignored because the effects are less important than those mentioned. In order to get an approximate idea of the magnitude of the centrifugal force appearing in a turbine unit of 15,000 kw. output and 1,500 r.p.m., it can be stated that the maximum force will be approximately 660,927 lb.

In the static calculation, the centrifugal force produces a distinct load (Fig. 1). A further load (which will be given prime consideration as we proceed to the static investigations) is represented by the vertically acting dead load of the machine (Fig. 2).

To begin with, Doctor Rausch assumed that the double magnitude of these quantities would be sufficient. Taking into consideration the holes for anchor bolts and other openings in the bedplate—that is to say, in view of the weak points of the reinforced concrete body—he further suggests that three times the dead load be used.

A consideration of the third case of loading involves an investigation of the foundation with regard to the danger of tipping. This dangerous factor can appear at a sudden violent breaking of the machine unit, or in the case of a short-circuit in the generator. It is regarded as sufficiently safe to consider the oscillating masses as the force attacking horizontally in the gravity point of the masses and to require double safety against tipping of the foundation. The oscillating masses include the weight of the machine unit, the bedplate and approximately the upper third part of the supports.

The Elimination of Resonance

As is known, there is created a resonance in the entire machine unit. This resonance can easily become dangerous when the natural number of oscillations of the foundation (natural frequency) coincides with the operating speed of the unit, or in case these two values harmonize too closely. According to Dr. J. Geiger, the divergence should be approximately ± 30 per cent of the machine speed. Attempts should be made to attain a natural frequency (considering vertical direction of the force) of a minimum of 30 per cent above the ma-

VIBRATION is a matter of so great importance that this authoritative and thorough-going article merits extended treatment, and should be studied by engineers concerned with laying out foundations for high speed machinery. *Power* readers are indebted to Mr. Oscar F. Junggren, Consulting Engineer of the General Electric Co. for calling attention to the importance of this discussion.

*Abstract of translation prepared by Main Library of General Electric Co. of original article which appeared in *Siemens Zeitschrift*, Vol. 6, No. 9, September, 1926, pp. 458-66.

chine speed, and not less than 30 per cent (considering horizontal direction of the centrifugal force) below the r.p.m. of the machine. When a larger difference, which may be suitable under certain circumstances, is presumed, attention should be paid to the fact that the natural frequency and the number of revolutions should not have an harmonic ratio.

The higher the natural frequency the smaller the oscillation amplitude (the double deflection of a beam, a support or foundation base) will be. As is known, the impact of the oscillation movement increases as the square of the amplitude, and attempts have been made to limit the deflection, and consequently the oscillation amplitude, to a minimum by making the natural frequency as high as possible. The oscillations also have a certain influence upon the fatigue of the material.

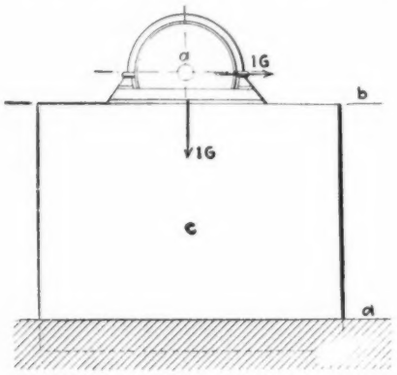


Fig. 1—The effect of the centrifugal force
(a)—Turbine. (b)—Floor. (c)—Turbine foundation. (d)—Lower floor.

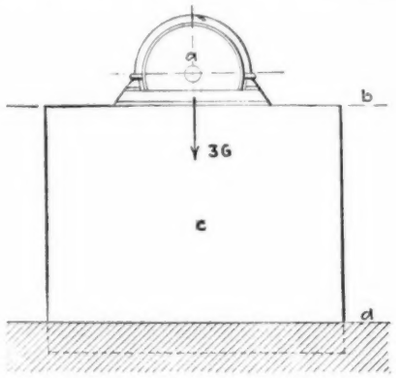


Fig. 2—The effect of the dead machine load
(a)—Turbine. (b)—Floor. (c)—Turbine foundation. (d)—Lower floor.

With a natural frequency of 2,000 cycles per minute, the oscillation amplitude is 2×0.0087, or 0.0174 in. At a natural frequency of 4,000 cycles per minute the corresponding value is only 2×0.0024 in., or 0.0048 in. Thus the ratio between the impacts in these two cases is

$$\frac{0.0174^2}{0.0048^2}$$; that is to say, in the latter case the impact is only 1/13 of the magnitude of the first case.

However, with the first case the impact takes place 2,000 times within one minute, while in the second case it appears 4,000 times within one minute, that is, at a ratio of 1 to 2, and thus the ratio of 1 to 13 changes in favor of the second foundation. The active output of the impacts in the first case will be approximately 7 times larger than in the second case. In this consideration we do not pay attention to the fact that the first foundation with the stronger impact has a comparatively smaller mass with which to stand up against the impact, while in the second foundation the smaller impacts will have to work against heavier masses. Thus, the higher the natural frequency of the foundation the larger the required moment of inertia and consequently the larger the cross-sections of the foundation parts.

The Building Ground Question

Up to the present the carrying capacity of the building ground for dead loads has been considered principally in order to give the foundation a sufficiently large base area. However, practical operation has proved that these calculations, based upon the dead loads, do not include all the various factors and that it is necessary to consider also the influence of the oscillation phenomena upon the building soil. The building ground, which under the strain of the dead loads can be termed as entirely satisfactory can, under certain conditions and in the course of time, lose its favorable properties to such an extent that it finally becomes directly dangerous to the operation of the machine, if not to the foundation itself.

The first example to be mentioned pertains to a turbine unit of 25,000 kva. and 1,800 r.p.m. The building ground upon which the foundation was built consisted of gravel and sand. The ground water reached such a level that a large part of the base of the foundation was submerged in the water. It was found that this condition was dangerous to the operation of the machine. After the unit had been kept running for a long time without any disturbance, the foundation began settling. This gradually reached such an extent that it finally was decided to discontinue the operation of the machine. The first substructural precautions for bringing the foundation into a steady state failed entirely. Finally, however, the foundation was put in a permanently safe condition by using additional piling (the Wolfsholz compressed concrete method).

Thorough investigations were made to ascertain the reasons for the settling. The main conclusions reached were as follows: As stated, the building ground, which in itself was satisfactory, *was permanently submerged in flowing ground water.* Owing to the oscillation amplitude of the foundation supports (oscillation amplitude approximately 0.0174 in.) the foundation base was induced into a state of vibration (see Figs. 3 and 4). Under this presumption it can be said that the base at one moment has a pounding effect upon the sand and the gravel, and in the next moment has a sucking influence upon the ground water. In other words, there is literally a gravel-washing device in operation, which causes a separation of the various elements of the soil. The fine sand will be pulled toward the bottom side of the foundation base, and its fine soluble elements, such as loam and clay, will be dissolved in the ground water and washed away with the ground water current. In this manner a cavity is formed with the result that the foundation with its load of more than 2,200 tons (dead load) will follow and settle. This process had been going on steadily, and in the course of time the settling reached such an extent that the machine was forced out of operation.

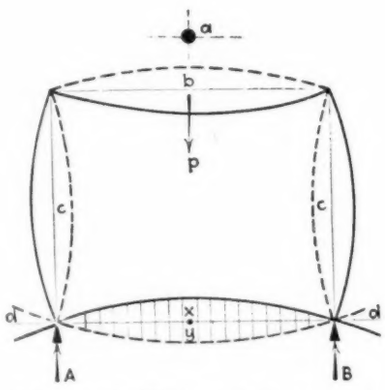


Fig. 3—Oscillations due to vertically acting force
(a)—Shaft. (b)—Beam. (c)—Support. (d)—Base.

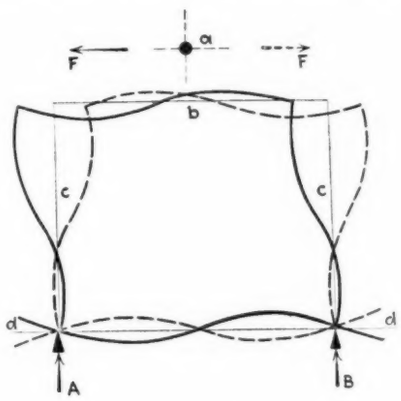


Fig. 4—Oscillations due to horizontal acting force
(a)—Shaft. (b)—Beam. (c)—Support. (d)—Base.

At first consideration the theory stated here and advocated, among others, by Professor Morsch, Stuttgart and Professor Gehler, might not seem reliable. It might be assumed that the oscillation amplitudes of the base cannot release any noticeable forces. However, it should be realized that a unit of

16,000 kw., running at 1,500 r.p.m. and with a base weighing 1,320 tons (including the weight of the condenser) will exercise in the course of one year a beating and vacuum action one billion times, roughly estimated, with an oscillation amplitude of 0.0174 in., giving an average output of approximately 50 hp. with a maximum of 137 hp. When these data are considered, it is more easily understood that the working of the base represents quite an appreciable expenditure of energy, fully capable of causing the destruction of the soil as described.

As a proof of the correctness of the theory that these squashing phenomena (disregarding the manner in which they are brought about) are the final causes for the settling, attention is called to the fact that several cubic yards of concrete could be pressed underneath the base without any particular difficulty.

As a further proof the following statements will also be considered: When the additional piling was being placed under the foundation, it was found that the soil within the oscillation range of the foundation base had been so loosened that it could easily be removed with a spade, while the soil under the row of supports (the stationary points under the oscillating base, *A* and *B* in Fig. 3) was pressed together so firmly that it could be removed only by means of a pickax. It can be explained that the soil at these points, at certain times, was subjected to the total load of the turbine and the foundation and thus had to withstand a pressure many times that of the permissible load.

Danger of Flowing Ground Water

It is obvious from the foregoing consideration that flowing ground water can be dangerous to a turbine foundation, even when it rests on good soil, such as gravel and sand. In such cases, therefore, the foundations should be built on piles. Even when the ground water does not show any tendency to move at the time of the erection of the foundation, piling should be used because it can often happen that the stationary ground water later starts flowing. This can be caused by neighboring mining activities, well drilling, lowering of the ground water level (although the latter in case of substructures may be of a temporary nature), lowering the level of rivers caused by flow regulations, and various other reasons.

There are also other reasons for building turbine foundations on piling. Not only may the soil, consisting of sand and gravel with moving ground water, be dangerous to the stability of the turbine foundation, but loam can also be a very questionable ground material.

The following experiences were had with a turbine unit of 15,000 kw. running at 1,500 r.p.m. The building ground consisted of moist loam (water content about 11 to 13 per cent) with fine veins of sand. When the foundation pit was being excavated, the building ground was found to be favorable and of so firm a nature that it could not be dug out by means of spades, but the laborers were forced to use pickaxes. Tests indicated that the ground could be entrusted with a maximum permissible loan of 21.6 per sq.in. This load was considered more than safe as the calculation of the foundation was based upon an additional weight of 500 per cent in order to take care of vibrations. Under these presumptions the soil pressure would be far below 21.6 lb. per sq.in. The masonry part of the power station exerted a pressure on the soil of 21.6 lb. per sq.in., but with these foundations no settling was observed. However, with the turbine foundation the first settlings, although slight, appeared after but a short time of operation. These settlings were equally larger at all four corners of the foundation, and in the course of time they increased to 1.1 in. In fact,

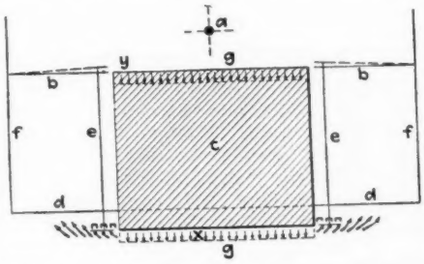


Fig. 5—Example of relative displacement between the turbine foundation and the turbine-room floor, the soil consisting of loam.

(a)—Shaft. (b)—Floor. (c)—Turbine foundation. (d)—Lower floor. (e)—Floor support. (f)—External wall. (g)—Settling.

they amounted to only 0.91 in., because closer investigations showed that the turbine-room floor had been raised 0.19 in. at the gap between the foundation and the floor (Fig. 5).

Explanation of Settling

These phenomena may be explained by the behavior of the soil, the ground material being of a particular nature. The foundation base, resting upon the loam, literally acts as a kneading machine (Figs. 3 and 4). In the course of time the water content of the loam is pressed out owing to the beating and vacuum action. During this process the space required by the pressed layer gradually becomes smaller. Also, the layer attains such a strength that it can stand up against the further attacks of the foundation. On account of the reduced volume of the latter, the foundation naturally will settle. During the further kneading of the layer a part of the loam will be pressed to the side on account of its plasticity. The loam which is pressed out from underneath the foundation base, will in part be forced under the foundations of the immediately neighboring floor supports, and the latter will be lifted upward. This presumption, which at first seems improbable, becomes the more credible when it is realized that the floor foundations have incomparatively large base areas, these foundations being calculated for a useful floor load of 307 lb. per sq.ft. The floor is subjected to this heavy load only during a few exceptional cases and is not so burdened during the settling process. Thus the loam that is pressed out can easily raise the floor supports and the floor a slight amount.

It is impossible to determine beforehand the elevation of the foundations and floors so that the later gradual settling gives the intended level. Therefore, in case the building ground consists of moist loam, the best plan will be to place the turbine foundation on piling.

Other Advantage of Piling

By the use of piling, another problem that has been brought up was solved; namely, that the vibration of the building ground might be the reason for the resonance phenomena appearing when starting up the turbine, the foundation being ever so perfect.

The dimensions of the smallest foundation base, determined by the distance between the supports, permit of driving the necessary piles without any particular difficulty. Obviously, it is advantageous to place a certain number of these piles in a sloping position in view of the horizontally attacking centrifugal force. According to Doctor Rausch it is desirable that the resultants of the individual groups of sloping piles run through the axis at the gravity point of the entire structure (machine and foundation). According to Dr. Paul Muller the point of gravity should, if possible, lie in the lower third part of the total height of the foundation (from upper foundation edge to the lower edge of the foundation base).

The improvement of the building ground by a system of piles means an additional expense. However, the greater part of the additional cost can be considered as eliminated because the installation of the turbine foundation is made independent of neighboring substructures, smokestack foundations, cooling-water canals, pump sumps, etc. This means that the foundation base does not any longer necessarily have to be placed as low as the deepest foundation base of the neighboring structures. A foundation base of the ordinary dimensions will suffice.

The preparatory investigations may have proved, however, that the *quality of the building ground and the permanence of this quality* will stand up against the attacks of the oscillating masses. In this case the piling can be omitted without hesitation, and the foundation base can be built so as to meet the ordinary strength requirements. However, it is advisable that the base be of such dimensions that it has the highest possible natural frequency, so that the effect of the oscillation will be reduced to a minimum.

The R. E. Lee Wilson Company, has been given a franchise to furnish electric power to Tyronza, Arkansas. The company paid $13,000 for the franchise. After bidding between the Arkansas Public Service Company and Mr. Wilson, the latter's proposal was accepted.

NEWS *of the* FIELD

New London Diesel Completes Thirty-day Test

The last of the large Diesels ordered by the United States Shipping Board ended its 30-day test on July 17 at the Groton, Conn., shops of the New London Ship & Engine Co., and will be dismantled to be installed in the converted steamship "Willscox."

This four-cylinder two-stroke-cycle double-acting Diesel developed 3,680 hp. continually during the test run, and has the record of being the only one of the engines purchased by the Shipping Board to operate the entire 30 days without a stop. The set speed is 115 r.p.m., but there is every reason to expect that the speed can be raised to 125 r.p.m., giving an output of approximately 4,500 hp. The fuel consumption, while not announced officially, works out at 0.45 lb. per boiler horsepower-hour

The unit is very quiet in operation, owing to the absence of much valve gearing and to the design of the pump. As in the case of other M. A. N. Diesels built for the Shipping Board, the three-stage compressor is placed between two pairs of working cylinders, with the double-acting scavenging air pump at one end of the engine. The entire working stresses are taken up by long tension rods passing from the head block or entablature to the base. The cylinder jacket and levers carry no part of the actual stresses and are therefore of simple form and not unduly thick.

Four fuel valves are used in each of the lower cylinders, while each top cylinder has a single spray valve. The four lower sprays are served by a single pump with a distributor provided with adjusting needle screws. Reversing is obtained through a hydraulic ram which lifts the valve-rocker push rod and shifts the cam shaft longitudinally.

Plans for Electrotechnical Meeting Are Outlined

Further detailed plans for the participation of the American delegation at the International Electrotechnical Commission 1927 meeting to be held at Bellagio and Rome, Italy, Sept. 4-24, was given out at the recent meeting of the United States National Committee.

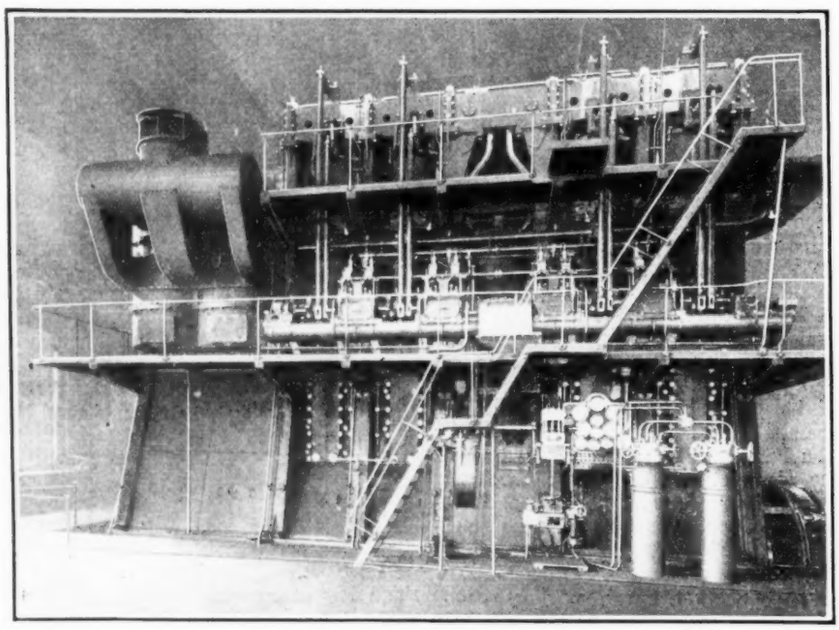
In view of the advantages in having the American delegation as far as practicable at the same hotel, it was suggested at the meeting that the Hotel Grande Bretagne be chosen; furthermore, in order that the committee may have a record of the plans of all the delegates, it was decided that the questionnaire sent to delegates and representatives as to their plans for participation, be filled out and returned to H. S. Osborne, secretary-treasurer, 33 West 39th St., New York City, to be forwarded to the Italian Electrotechnical Committee.

Clayton H. Sharp, president of the United States National Committee of the International Electrotechnical Commission, has appointed as secretary to the American delegation Dr. J. F. Meyer, who will be given a copy of the list of delegates and their plans, so far as they are received at the secretary's office. Dr. J. F. Meyer can now be reached care of Hotel Grande Bretagne, Bellagio, Italy.

Preliminary Program

The American delegation will reach Bellagio from Como the afternoon of Sept. 4, and on the following day there will be a number of experts' papers on prime movers. Sept. 6 and 7 will be principally devoted to studies on hydraulic turbines, rating electrical machinery, voltages and insulating oils; on Sept. 8 will be considered steam turbines, nomenclature, terminal markings, screw lamp caps and holders, symbols and rules and regulations. A visit the following day will be made to the Liro Electrical plant. On Sunday, Sept. 11, a solemn celebration of the centenary of Volta, in conjunction with the International Congress of Physics, will be held at Como. Sept. 12-13 will be given over to papers and discussions on traction motors, radio lamps, rating of rivers and measuring instruments.

Departure from Bellagio Sept. 13 for a tour to Milan, Venice and Florence will terminate at Rome for the plenary meeting in the Immortal City, Thursday, Sept. 22.



New London Double-acting Two Stroke-cycle Diesel

Marine Boiler in 240-Hr. Test with Pulverized Coal

For some time experiments have been going on at the United States Naval Fuel Testing Plant, Philadelphia Navy Yard, with a view to adapting pulverized-coal firing to marine use, especially on vessels of the Shipping Board. Several types of equipment have been tried out on a Scotch marine boiler, set up on land, but representing a unit of the steamship "Mercer" which has been allocated to this purpose. There is now being run a 240-hour continuous test on this equipment served by a unit mill of the slow-speed type. Forced draft and preheated air are employed. When installed on shipboard there will be two pulverizers serving three boilers.

Newark N. A. S. E. No. 3 Elects Officers

Members of the National Association of Stationary Engineers, Newark, N. J., Local No. 3, meeting at a recent business meeting elected as officers the following: A. Krill, president; H. H. Baumgartner, vice-president; G. Katsch, recording secretary; F. McLain, corresponding secretary; J. Savage, treasurer; H. Wormald, doorkeeper, and W. Strauka, conductor. The local will be represented at the national convention at Los Angeles, Aug. 22-27.

Program for National Fuels Meeting Is Announced

Preparations for the National Fuels meeting to be held in St. Louis Oct. 10-13, are progressing toward an excellent meeting. Sponsored by the Fuels Division of the American Society of Mechanical Engineers, this gathering will feature production, purchase, classification and the proper burning of fuel, as well as smoke abatement and other subjects that will be discussed from domestic, industrial and power viewpoints.

Outstanding engineers and scientists in the fuel field will participate. Great interest is being shown throughout the country by individual engineers, heads of industry and governing boards of various engineering societies, as this meeting will create a centralized forum where all engineers, regardless of their society affiliations, may discuss the current fuel problems of the day. For those who may have overlooked previous announcements of this meeting, an outline of the program follows:

"Address on Fuels," by Prof. S. W. Parr, University of Illinois; "American Fuel Resources," by O. P. Hood, chief mechanical engineer, U. S. Bureau of Mines; "Combustion and Heat Transfer," by Prof. R. T. Haslam, and H. C. Hottel, Massachusetts Institute of Technology; "The Clinkering of Coal Ash," by A. C. Fieldner, chief engineer of Experiment Stations, U. S. Bureau of Mines; "Factors Governing the Purchase of Fuels," by Morgan B. Smith, engineer, General Motors Corp.; "Refractories for High Temperatures," by Stewart Phelps, director of research and tests, American Refractories Institute Fellowship, Mellon Institute; "Coal Mining and Coal Preparation from Standpoint of Quality"; "Recent Developments in Low-Temperature Coal Carbonization," by H. D. Savage, vice-president, Combustion Engineering Corp.

Industrial Studies

"Industrial Applications of Heat," by Prof. W. Trinks, Carnegie Institute of Technology; "Progress in Gas Producer Practice," by W. B. Chapman, president, Chapman Engineering Co.; "The Use of Fuels in Brick Kilns," by W. E. Rice, assistant fuel engineer, U. S. Bureau of Mines; "The Burning of Liquid Fuels," by Ernest H. Peabody, president, Peabody Engineering Corp.; "Rotary and Vertical Kilns for Cement, Lime and Gypsum," "Application of Powdered Fuel to Smaller Boiler and Industrial Installations," by H. W. Brooks, consulting engineer, Erie City Iron Works; "The Relative Values of Gaseous, Liquid and Solid Fuels," by F. C. Binnall, Assistant manager, Standard Sanitary Manufacturing Co.

Power Plant

"Characteristics of Modern Boilers," by E. R. Fish, vice-president, Heine Boiler Co.; "Characteristics of Modern Stokers," by F. H. Daniels, president, Riley Stoker Co.; "Air Preheaters," by Frank M. Van Deventer, special engineer, Henry L. Doherty Co.; "Direct Fired Powdered Fuel Boilers with Well Type Furnaces at Charles R. Huntly Station," by H. M. Cushing, chief engineer, Buffalo General Electric Co.; "Automatic Combustion Control," by J. A. Peebles, chief engineer, Hagan Corp.

Contributions on Smoke Abatement

"The Measurement of Atmospheric Smoke Pollution, Visible and Invisible," by Dr. George T. Moore, director, Missouri Botanical Garden; "Smoke Abatement Methods Used in Cleveland," by Col. Elliott H. Whitlock, Commissioner of Smoke Inspection; "Managing a Smoke Abatement Campaign," by Erle Ormsby, president, Citizens' Smoke Abatement League; "Furnace Essentials for Smokelessness," by H. B. Moller, chief, Bureau of Smoke Regulation, Pittsburgh; "Smokeless and Efficient Firing of Domestic Furnaces," by Victor J. Azbe, consulting engineer, St. Louis; "The Effect of Atmospheric Smoke Pollution—a Summary of Opinions from Current Literature," by Prof. A. S. Langsdorf, director of industrial and engineering research, Washington University.

Westinghouse Officials Visit Cheat Haven Plant

Approximately 700 officials and engineers visited the Cheat Haven hydroelectric generating station of the West Penn Power Co. Saturday, July 23. The trip, sponsored by the West Penn Co., was arranged for Westinghouse Electric & Manufacturing Co.'s officials and employees, most of whom represented the Manufacturing Inspection Department Association of that company.

J. S. Jenks, vice-president of the West Penn Power Co. and J. E. Thomas, superintendent of operations, directed the tour. Others in the West Penn party were A. N. Cartwright, general superintendent, power distribution; W. E. Higgins, purchasing agent, and H. W. McRobbie, superintendent of substations.

Westinghouse officials on the excursion included W. S. Rugg, vice-president in charge of engineering; Roscoe Seybold, assistant to vice-president and general manager; J. McA. Duncan, assistant general sales manager; R. S. Feicht, director of engineering; R. L. Wilson, works manager; E. S. McClelland, director of personnel, and C. S. Coler, educational director.

The Cheat Haven Power plant, located on the Pennsylvania-West Virginia line, is the first of several plants projected for the Cheat River. The entire plant, with the substations on an adjoining hill, is operated by three men per shift. The station has a rated capacity of 50,000 kw. The dam contains 150,000 cu.yd. of concrete, anchored to bedrock. The reservoir normally extends 13 miles upstream and contains 73,000 acre-feet.

Waves from Plant Operation As Subject of Study

Observations of the persistence of waves caused by irregular power plant operation, at the instance of the Federal Power Commission, are to be made on a number of rivers of varying characteristics.

Studies recently completed by the Oregon-California Power Co. show that the waves produced at its Copco plant on the Klamath River are practically undiminished at a distance of 64 miles from the plant and show only a 25 per cent reduction 132 miles away.

The gages at the 64-mile and 132-mile stations were read at thirty-minute intervals throughout the day and night for a period of six days.

Similar results previously had been noted on the Pitt River. That particular study had an important bearing on the Commission's action in assuming jurisdiction over the project at Radford, Va., on the New River. The Klamath results tend to support the exceptions taken by the Commission's engineers to claims that these impulses disappear a few miles from the plant. These studies will have an important bearing in the consideration of future declarations of intention.

Westinghouse Men Beginning Visit to Cheat Haven Plant

British Power Stations Enjoy Increased Efficiency

A broad survey of the progress that has been achieved in British power stations during the last four years has recently been made the subject of an interesting study by the British Electrical Manufacturers' Association.

In this period the units generated have increased from 4,740,000,000 kw.-hr. to 7,805,000,000 kw.-hr., the corresponding consumptions of coal being 6,577,587 tons and 8,396,872 tons respectively. This will be seen to have effected a reduction in the amount of coal used per unit from 3.11 lb. to 2.40 lb., which, with the developments that are in progress, will in course of time make an important saving in the fuel consumption of the country.

In the most successful stations results in thermal efficiency are being regularly obtained which are easily commensurate with those obtained in the more spectacular stations in the United States. So great is this improvement that, had it been realized by the whole of the country's stations instead of only the twenty-five most efficient stations, a saving of fuel of 6,600,000 tons would have been effected.

Although recognizing the significance of the progress recently realized, the association clearly shows the advantage to be obtained by the larger-scale adoption of the more modern methods now coming into vogue.

Russia Shows Progress in Electrical Equipment

A 10,000 kw. turbo-generator, constructed in Leningrad, has been installed in the Petrovsky steel mill at Dniepropetovsk, Soviet Russia. This is the largest turbine ever turned out in Russia. The Leningrad plants will make for the Electrotok Trust two 22,000 kw. turbo-generators.

A concession agreement has been signed granting to the Swedish concern Assea the right to construct and operate at Yaroslavl on the Volga River a plant producing electrical machinery. The concession runs for 35 years.

In connection with electrical development in Russia the Amtorg Trading Corporation of New York announces that additional orders valued at $250,000 have been placed in the United States for construction equipment for work on the 650,000 hp. hydro-electric development on the Dnieper River in the Soviet Union. Since the beginning of April equipment valued at upward of $500,000 has been purchased here for the Dnieper work.

Tri-City A. S. M. E. Holds Election

The Davenport, Ia. and Moline-Rock Island, Ill. tri-city section of the American Society of Mechanical Engineers has elected Lieut.-Col. G. F. Jenks, of Rock Island Arsenal, as chairman; E. D. Quirke, Kewanee Boiler Works, Kewanee, vice-president; Charles A. Carlson, John Deere Plow Works, Moline, secretary-treasurer, and Thomas L. Wilkinson, Davenport, A. E. Lindberg, Moline Tool Co., and Louis Ruthenburg, Yellow Sleeve Valve Engine Works, East Moline, executive committee.

Plans for the year's work will be taken up at the next meeting.

Sends Engineers Abroad for Flood Prevention Study

Through the establishment of a fund by Dr. John R. Freeman for the investigation of flood prevention, two civil engineers have been awarded scholarships this summer for a year's travel and study in Europe in the field of hydraulics.

Doctor Freeman, who is a past-president of the American Society of Civil Engineers, made that society a custodian of his gift fund of $25,000. The first to go is Herbert N. Eaton, who sailed July 16 to join Dr. Freeman in Germany. Mr. Eaton has been associated with the Bureau of Standards for a number of years.

Doctor Freeman suggested that the income be used once in three years for a traveling scholarship for the purpose of aiding and visiting engineering works in the United States or other parts of the world where there is good prospect of obtaining useful information to engineers.

The income from the $25,000 is sufficient thus far to provide for but one student. However, the credentials of Prof. Blake R. Vanleer, of the University of California were so fine that Doctor Freeman authorized the society to send Professor Vanleer. He was nominated by Ely C. Hutchinson.

Doctor Freeman has also arranged for other men to go through selection by the A.S.C.E. and the Boston Society of Civil Engineers. M. P. O'Brien, graduate student of civil engineering, Purdue University, is one of those already chosen for this study.

Royal Gorge Project Up

The Public Service Co., Colorado, has applied to the Federal Power Commission for a preliminary permit covering the so-called Royal Gorge project on the Arkansas River in Fremont County, Col. The power site is near Canyon City. It is proposed to install equipment capable of developing 33,000 hp. The primary power available is estimated at 16,000 hp.

Urges Settlement by States

The American Society of Civil Engineers at its recent Denver convention passed a resolution suggesting that all controversies over waters of interstate rivers be settled by treaty between the states affected, instead of litigation in the courts.

Colorado Coal Output Grows

For the month of June, Colorado mined 591,562 tons of coal. This brought the total for the first six months of 1927 up to 4,913,775, an increase of 265,005 tons over the corresponding period of 1926.

Obituary

WILLIAM J. RICE, deputy state boiler inspector of Colorado, died suddenly July 12 while in the act of inspecting the boiler of the Great Western Sugar Co. at Brush, Colorado. Mr. Rice was in his forty-sixth year.

Personal Mention

JOHN J. KELLY, of Denver, was appointed July 22 deputy state boiler inspector for Colorado. He succeeds W. J. Rice who died three weeks ago.

F. R. NICHOLAS, an engineer formerly connected with the municipal lighting department of Seattle, but now serving in a new capacity, has announced that he has been engaged by a group of smaller cities and towns in the state.

G. J. FINK, formerly chemical director of the National Lome Association, Washington, D. C., has been appointed head of the new research department of the Chicago Chemical Co., water service engineers and manufacturers of the K.W.S. sodium aluminate.

FRANCIS HODGKINSON, consulting mechanical engineer of the Westinghouse Electric & Manufacturing Co., will sail for England on Aug. 6. After completing his engagements he plans to attend the meetings of the International Electrotechnical Commission at Bellagio and Rome, Italy, September 4 to 21, as a member of the group of technical experts representing the United States.

E. D. TREANOR has been appointed manager engineer of the distribution transformer department at the Pittsfield, Mass., works of the General Electric Co. As managing engineer of that department, Mr. Treanor will also have general supervision of the engineering on distribution transformers manufactured at the Fort Wayne, Ind., and Oakland, Calif., works of the company.

PROFESSOR I. G. ALEXANDROV, the originator of the Dnieper River power project, which will be the largest hydro-electric development in Europe, has arrived in this country from the Soviet Union to study large scale hydro-electric power plants and equipment factories. Professor Alexandrov will negotiate purchases of structural machinery, equipment, including excavating machinery, and will examine 50,000-hp. generators, of which seven will be installed in the Dnieper plant in its early stages. Professor Alexandrov intends to remain here about three months.

Business Notes

THE CHICAGO PNEUMATIC TOOL CO., 6 East 44th St., New York City, announces the removal of its Seattle branch office, service department and warehouse Aug. 1, from 119 Jackson St. to 1743-47 First Ave., South, Seattle, Wash.

THE ROLLER-SMITH CO., 233 Broadway, New York, N. Y., announces two new instruments, the Type COM Ohmmeter and the Type HTD circuit tester. These two new instruments are illustrated and described in Supplement No. 1 to Bulletin No. 300.

THE AMERICAN ROLLING MILL CO. has acquired the property, plants, business and patents of the Columbia Steel Co. and the Forged Steel Wheel Co. at Butler, Pa., and Elyria, Ohio. The Columbia Steel Co. will, for a period as yet undetermined, be operated as a separate company, but the entire product will be sold by Armco.

THE LINCOLN ELECTRIC CO. announces that the Missouri district office has been moved from 1808 Railway Exchange Bldg., St. Louis, to 1003 Davidson Bldg., Kansas City, Robert Notvest being in charge. The St. Louis District will be handled by Mr. Notvest, his time being divided between the two cities. A branch office has also been established at 220 Nicholas Bldg., Toledo, Ohio, with A. H. Homrighaus in charge.

Trade Catalogs

VARIABLE SPEED TRANSMISSION — The Stephens-Adamson Manufacturing Co., conveying tranmission and screening machinery, S.-A. belt conveyors, Aurora, Ill., has issued a new bulletin illustrating and describing the new JFS variable speed transmission now being placed on the market.

DROP-FORGED WRENCHES—The twentieth edition of the catalog of J. H. Williams & Co., Buffalo, N. Y., describes a line of alloy steel drop-forged wrenches of various types and includes substitution list for sizes eliminated from the standards. Lathe-tool holders and dogs, clamps and other tools are also listed.

MECHANICAL DRIVE TURBINES—Bulletin GEA-578A of the General Electric Co. describes a line of steam turbines adapted to driving power-plant auxiliaries and factory machinery of special types. The turbines are available in capacities of 5 to 700 hp. at speeds from 1,000 to 5,000 r.p.m. The impulse type is pressure-compounded if of more than one stage, and velocity-compounded in each stage with two rows of moving buckets.

Coming Conventions

American Institute of Electrical Engineers. F. L. Hutchinson, secretary, 33 West 39th St., New York City. Pacific Coast convention at Del Monte, Calif., Sept. 13-16.

American Refractories Institute will hold its fall meeting Thursday, Sept. 15, at the Clifton Hotel, Niagara Falls, Canada.

American Water Works Association. California Section, at San Jose, Oct. 5-8; Paul E. Magerstadt, sec., East Bay Water Co., Oakland; North Carolina Section, at Durham, Nov. 7-9; H. G. Baity, sec., Univ. North Carolina, Chapel Hill; Southwest Waterworks Association will meet at Hot Springs, Ark., Oct. 10; Lewis A. Quigley, sec., superintendent of City Waterworks, Fort Worth, Tex.

American Society of Mechanical Engineers. Calvin W. Rice, secretary, 33 West 39th St., New York City. Seattle, Wash. Section, Aug. 29-31.

Canadian Steel and Power Show and technical sessions will be held at the University of Toronto Arena, Toronto, Ont., Aug. 31, Sept. 1 and 2; Campbell Bradshaw, general chairman of exposition committees, 153 University Ave., Toronto, Ont.

National Association of Practical Refrigerating Engineers. Eighteenth annual convention and educational exhibition in Civic Convention Hall and headquarters Hotel Whitcomb, San Francisco, Calif., Nov. 29 to Dec. 2. H. Fox, 5707 W. Lake St., Chicago, Ill.

National Association of Stationary Engineers—Annual convention at Ambassador Hotel, Los Angeles, Calif., Aug. 22-27, in connection with the Pacific Coast Power and Mechanical Exhibit.

National Fuels Meeting, under the auspices of the Fuels Division of the American Society of Mechanical Engineers, will be held Oct. 10-13 at St. Louis, Mo.

Universal Craftsmen Council of Engineers. Thomas H. Jones, secretary, 33 Linden Ave., Cherrydale, Va. Annual convention at Buffalo, N. Y. Aug. 2-6.

CALISCOPES — The American Temperature Indicating Co., Toledo, Ohio, has published an illustrated bulletin on Caliscopes, electric devices for indicating temperatures at remote distances by giving dry and wet bulb readings, relative humidity and temperature variations.

INDUCTION FREQUENCY CHANGERS—Frequency changers for supplying power to high-speed motors at frequencies above normal are described in bulletin GEA-750 of the General Electric Co. The machines are driven by induction motors, are a.-c. excited and deliver power at from 60 to 420 cycles. Standard voltages for given frequencies have been adopted after a consideration of effects on interchange of equipment, and a table including these and other data is given.

THE NEW WATER-SUPPLY SYSTEM AT TAMPA, FLORIDA, was recently described and illustrated in an elaborate paper presented by Nicholas S. Hill, Jr., consulting engineer, before the New England Water Works Association. The paper covers studies of water supply and treatment and describes briefly the mechanical equipment. The paper has been reprinted and is being distributed by the De Laval Steam Turbine Co., Trenton, N. J., manufacturers of the geared turbine-driven centrifugal pumps installed in the low-head and high-head pumping stations at Tampa.

THERMOSTATIC TRAPS—Bulletin 1200 of Warren Webster & Co. contains a description of series 78 thermostatic traps for process steam pressures. It points out the disadvantages of air and condensate in process steam and illustrates the use of traps in such cases.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run except Pittsburgh gas slack:

Bituminous Net Tons	Market Quoting	July 27, 1927
Pool 1	New York	$2.50@$2.75
Smokeless	Boston	1.61
Clearfield	Boston	1.60@ 1.90
Somerset	Boston	1.70@ 2.00
Kanawha	Columbus	1.25@ 1.50
Hocking	Columbus	1.75@ 1.90
Pittsburgh	Pittsburgh	1.90@ 2.15
Pittsburgh gas slack	Pittsburgh	1.40@ 1.60
Franklin, Ill.	Chicago	
Central, Ill	Chicago	
Ind. 4th Vein	Chicago	
West Ky.	Louisville	2.00@ 2.25
S. E. Ky.	Louisville	1.40@ 1.65
Big Seam	Birmingham	1.50@ 2.15
Anthracite Gross Tons		
Buckwheat No. 1.	New York	2.50@ 3.25
Buckwheat No. 1.	Philadelphia	2.50@ 3.00
Birdseye	New York	1.35@ 1.50

FUEL OIL

New York—July 28, light oil, tank-car lots; 28@34 deg. Baumé, 5¼c. per gal.; 36@40 deg., 5½c. per gal. f.o.b. Bayonne, N. J.

St. Louis—July 21, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.65 per bbl.; 26@28 deg., $1.70 per bbl.; 28@30 deg., $1.75 per bbl.; 30@32 deg., $1.80 per bbl.; 32@36 deg., gas oil, 4.6c. per gal.; 38@40 deg., 5¼c. per gal.

Pittsburgh—July 27, f.o.b. local refinery; 30@34 deg., fuel oil, 4¾c. per gal.; 36@40 deg., fuel oil, 5c. per gal.

Philadelphia—July 28, 27@30 deg., $2.20½@$2.26½ per bbl.; 13@19 deg., $1.68@$1.74 per bbl.

Cincinnati — July 26, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 6½c. per gal.; 26@30 deg., 6⅝c. per gal.; 30@32 deg., 7c. per gal.

Chicago—July 21, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., 97½c. per bbl.; 26@30 deg., $1.00; 30@32 deg., $1.10.

Boston—July 25, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.3c. per gal.; 28@32 deg., 5.9c. per gal.

Dallas—July 23, f.o.b. local refinery, 26@30 deg., $1.40 per bbl.

NEW PLANT CONSTRUCTION

Ala., Sheffield—Sheffield Hotel Co., c/o H. J. Frahn Co., Archt., will soon receive bids for the construction of a 9 story hotel. Estimated cost $750,000.

Calif., Berkeley—Berkeley Hotel Corp., c/o W. H. Weeks, 369 Pine St., San Francisco, Archt., is having plans prepared for the construction of a 6 story hotel at Durant and Bowdich Sts. Estimated cost $500,000.

Calif., Long Beach—All States Building Corp., O. B. Blackburn, Pres., c/o Pan American Bank, Los Angeles, awarded contract for the construction of a 14 story theatre and apartment building at Seaside Blvd. and Atlantic Ave. here, to Wilson & Bever, Anaheim. Estimated cost $1,400,000.

Calif., Los Angeles—El Paula Holding Co., awarded contract for the construction of a 4 story apartment building at Western Ave. and Hollywood Blvd. to Harris N. Dickerman, 315 West Ninth St. Estimated cost $600,000. Electric refrigeration system, elevators, etc. will be installed.

Calif., Los Angeles—Guardian Holding Co., Commercial Exchange Bldg., had preliminary plans prepared for a 13 story office building, at 218-24 South Bway. Estimated cost $750,000. K. McDonald, Spring Arcade Bldg., is architect.

Calif., Los Angeles—Lilly-Fletcher Syndicate, c/o Walker & Eisen, Western Pacific Bldg., is having preliminary plans prepared for the construction of a 13 story apartment building at Wilshire Blvd. and Alexandria Ave. Estimated cost $1,000,000.

Calif., Los Angeles—Pacific South West Trust & Savings Bank, 565 S. Spring St., is having plans prepared for the construction of a 12 story bank and office building at Highland Ave. and Hollywood Blvd. Estimated cost $500,000. Meyer & Holler, Wright-Callendar Bldg., are architects.

Calif., Palm Springs — Palm Springs Hotel Co., awarded contract for the construction of a hotel on Indian Ave. to Orndorff Construction Co., 247 North Western Ave., Los Angeles. Estimated cost $550,000.

Steam heating system, etc., will be installed.

Calif., Pasadena—First Trust and Savings Bank and First National Bank, are having plans prepared for the construction of a 9 story bank and office building at Madison Ave. and Colorado St. Estimated cost $1,000,000. Bennett & Haskell, Security Bldg. are architects.

Conn., New Haven—Central Hotel Co., W. Lee, Pres., 246 Meadow St., plans the construction of a 12 story hotel at Meadow St. and Congress Ave. Estimated cost $1,000,000. Architect not selected.

Ind., Bloomington—City, E. Cooper, Clk., awarded contract for the construction of a filtration plant and pumping station to C. A. Pike. Estimated cost $63,977.

Ind., Elkhart—H. Weis Mfg. Co., awarded contract for the construction of a boiler house including radial brick stack unit heater boilers to I. Mast. Estimated cost $45,000.

Kan., Hutchinson—United Power & Light Co., awarded contract for the construction of a power plant to Stamey Construction Co. $200,000.

Ky., Fort Thomas—City, R. R. Pyne, City Bldg., Engr., will receive bids until Aug. 8 for the construction of a sewage pumping station. Whitman, Requardt & Smith, 18 East Lexington St., Baltimore, Md., are engineers.

Mass., Boston—Hospital Dept., Harrison Ave., awarded contract for the construction of addition to boiler room at City Hospital, Albany St. to Rideout, Chandler & Joyce, 178 High St. Estimated cost $78,954.

Mich., Berkley—Village plans waterworks improvements including wells, motor driven pump, mains, etc. Estimated cost $25,000. R. A. Murdoch Co., 602 Transportation Bldg., Detroit, is engineer.

Mich., Detroit—Michigan Bell Telephone Co., Cass Ave., awarded contract for the construction of a telephone exchange building including steam heating and ventilation systems, boilers, etc. at Selden Ave. to A. W. Kutsche, 2211 Woodward Ave. Estimated cost $900,000.

Mich., Detroit—Union Trust Co., Union Trust Bldg., awarded contract for superstructure of a 45 story office building including steam heating and ventilation systems, boilers, elevators, etc. at Fort and Griswold Sts. to A. A. Albrecht Co., 1117 Penobscot Bldg.

Mich., Muskegon—A. Kahn, Inc., 1000 Marquette Bldg., Detroit, Archt., will soon receive bids for the construction of a newspaper plant including boiler room, etc. at Clay and Third Sts., here, for Booth Publishing Co., 2500 Buhl Bldg., Detroit. Estimated cost $150,000.

Miss., Tupelo — U. S. Commissioner of Fisheries, Washington, D. C., will receive bids until Aug. 15 for the construction of a well and pumping plant at fisheries station here.

Mo., Columbia—W. E. Smith, is having plans prepared for the construction of a 9 story hotel and theatre building. Estimated cost $500,000. A. H. Gentry, March Bldg., Kansas City, is architect.

Mo., Columbia—The Tiger Inc., c/o W. E. Smith, will soon receive bids for the construction of a 9 story hotel and theatre building at South Eighth St. between Broadway and Cherry St. Estimated cost $500,000. A. H. Gentry, March Bldg., Kansas City, is architect.

Mo., Hermann—Missouri Pacific R.R. Co., Railway Exch. Bldg., St. Louis, awarded contract for the construction of a water treatment plant including pump, pumping equipment, etc. to Foundation Co., 1923 Main St., Kansas City.

N. J., Scotch Plains—Bd. of Chosen Freeholders of Union Co., City Hall, Elizabeth, will soon award contract for the construction of a hospital including power house, etc. here. Estimated cost $200,000. Oakley & Son, 1259 Clinton Pl., Elizabeth, are architects.

N. Y., New York—One Park Ave. Corp., 1 Park Ave., is having plans prepared for the construction of a 15 story hotel at 116-122 East 39th St. Estimated cost $500,000. Farrar & Watmough, 1 Park Ave., are architects.

N. Y., New York—Rhinelander Estate, c/o F. M. Valk, 31 Nassau St., awarded contract for the construction of two 11 story apartment buildings at 119-137 Lexington Ave. to J. H. Taylor Construction Co., 31 Union St. Estimated total cost $1,000,000.

O., Columbus—Acme Development Co., 17 South High St., soon awards contract for the construction of 12 story office building, East State St. Estimated cost $700,000. Miller & Reeves, 205 East Broad St., are architects.

Okla., Ponca City—City awarded contract for the construction of a power plant to Interstate Construction Co., 5703 Rockhill Rd., Kansas City, Mo. Estimated cost $123,960.

Pa., Philadelphia—J. E. Fox, Emlen St. and Lincoln Dr., plans the construction of a 4 story apartment at 5220 Wayne Ave. Estimated cost $500,000. E. L. Rothschild, Bankers Trust Bldg., is architect.

Tex., Balmorhea—Borderland Utilities Co., plans the construction of a waterworks system including wells, reservoir, pumps, mains, etc. Estimated cost $35,000. Private plans.

Tex., Barreda (mail San Benito)—Gillock Development Co., c/o Lasby & Crawford, San Benito, are having preliminary plans prepared for the construction of a waterworks system including power plant, mains, etc. Estimated cost $50,000. Private plans.

Tex., Beaumont—J. H. Crooker, Houston, and W. C. Keith, Beaumont, awarded contract for the construction of a 13 story hotel at Pearl and Wall Sts., here, to Southwestern Construction Co., West Bldg., Houston. Estimated cost $1,000,000.

Tex., Lufkin—City plans an election about Aug. 1 for waterworks improvements including pumping equipment, mains, etc. Estimated cost $85,000.

Tex., Wichita Falls—City plans an election soon to vote $500,000 bonds for waterworks improvements including pumping equipment, mains, etc. Black & Veatch, Mutual Bldg., Kansas City, Mo., are engineers.

Va., Richmond—Monroe Terrace Interests, F. E. Nolting, Dir., awarded contract for the construction of a 12 story apartment building to Wise Granite & Construction Co., American National Bank Bldg., and Allen J. Saville Inc., Electric Bldg. Estimated cost $1,100,000.

Vt., St Johnsbury—Mantin-Gaulin Mfg. Co., J. W. Davis, Pres., 11 Elkins St., South Boston, Mass., awarded contract for the construction of a factory and boiler house on Portland St., here, to J. M. Swan & Son., Inc., 144 Portland St., St. Johnsbury, Vt. Estimated cost $40,000.

Wash., Seattle—The Utilities Committee, of City Council, has voted to have the Corporation Council draw the bill necessary to enlarge hydro-electric plant at Cedar Falls including 14,000 kw. generator to replace present 8,000 kw. generators, also rebuilding transmission lines, etc. Estimated cost about $675,000.

Wis., Green Bay—Bd. of Education, I. W. McIntire, Supt., awarded contract for the construction of a heating plant for city high schools to Pharo Heating Co., Madison. Estimated cost $90,000.

Ont., Preston — Rock Brewery Co., awarded contract for the construction of a brewery on Brown St. to Frid Construction Co., 6 Houghson St. N., Hamilton. Estimated cost $100,000. Complete cooling equipment, vats, etc. will be installed.

Ont., Sandwich—Order of Elks, c/o H. I. Wiley, Capitol Theatre Bldg., Windsor, plans the construction of a 7 to 11 story club house including steam heating system, swimming pool, etc. at Park Pl. and Sandwich St. here. Estimated cost $750,000. B. Dore and C. H. Crane, Huron Bldg., Detroit, Mich., are architects.

Equipment Wanted

Air Compressor and Motor—O. F. Holcombe Mayor, Houston, Tex., will receive bids until Aug. 10 for furnishing and installing a centrifugal air compressor with motor complete in North Side sewage treatment plant.

Engines—Dept. of Public Works, Division of Canals & Waterways, T. F. Farrell, Comr., Albany, N. Y., will receive bids until Aug. 15 for one 500 hp. Diesel engine direct connected to centrifugal dredging pump and one 150 hp. Diesel engine direct connected to 100 kw. generator for hydraulic dredge, Syracuse, N. Y. Estimated cost $62,000.

Heating Plant Equipment—Bureau of Yards & Docks, Navy Dept., Washington, D. C., plans the installation of heating plant equipment including four 300 hp. water tube boilers, engine driven grate stokers, boiler feed pumps, blow-off pump and motor driven centrifugal sump pump, etc. in Naval Training Station (Hospital) Great Lakes, Ill.

Motors, Oil Burners, Etc.—T. J. Payette, Penetangushene, Ont., wants prices and catalogs on motors, and parts for oil burners, etc. for plant. Estimated cost $50,000.

Pump and Motor—City of Tecumseh, Okla., is in the market for a 50 g.p.m. deep well pump and 5 hp. motor.

Pump and Pumping Equipment—Grand River Sand Co., Manhattan Bldg., Muskogee, Okla., is in the market for a pump and gravel and sand pumping equipment.

Pumping Equipment, Etc.—City of Cassville, Mo., will be in the market for pumping equipment, etc. for proposad waterworks improvements. Estimated cost $37,500.

Pumping Equipment, Etc.—City of Longton, Kan., will be in the market for pumping equipment, etc. for proposed waterworks improvements. Estimated cost $50,000.

Pumps, Motors, Transformers, Etc.—West Stanilaus Irrigation Dist., Patterson, Calif., will be in the market for pumps, motors, substation transformers, etc. for proposed irrigation work. Estimated cost $854,255.

Refrigeration Equipment—Dept. of Mental Hygiene, Capitol, Albany, N. Y., will receive bids until Aug. 24 for refrigeration equipment for Harlem Valley State Hospital, Wingdale, N. Y.